SCIENCE

NEW SERIES.
VOL. VI. No. 156.

FRIDAY, DECEMBER 24, 1897.

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $5.00

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THE FOUNDERS OF GEOLOGY.

THE geologists of America in April of the present year welcomed to this country Sir Archibald Geikie, the distinguished Director-General of the Geological Survey of Great Britain and Ireland, on the occasion of his coming to give the opening course of lectures upon the George Huntington Williams memorial foundation at the Johns Hopkins University. The many representative men from all portions of America who went to Baltimore to listen to him shows the high position of authority which he holds in geological science and the desire which was universally felt to do honor to the man. Those who met him and listened to his carefully prepared words gained an inspiration which will be long felt in geology on this side of the Atlantic.

The lectures, which have been recently printed, appear in an attractive form from the Macmillan press.* In the introduction to the *first* lecture of the course the author states that the searcher after truth is liable to lose sight of the paths already trodden, and that it is, therefore, "eminently useful now and then to pause in the race, and to look backward over the ground that has been traversed, to mark the errors as well as the successes of the journey, to note the hindrances and the helps which we and our

* *The Founders of Geology*, by Sir Archibald Geikie, X. 297 pp. 1897. Macmillan & Co., London. The Macmillan Company, New York.

predecessors have encountered, and to realize what have been the influences that have more especially tended to retard or quicken the progress of research." For that purpose the epoch which extends from the middle of the last century to the earlier decades of this is especially selected as the period when the real foundations of geology were laid, although it is freely recognized that many honored names in the domain of the science antedated this time.

After referring to the curious coincidence of the appearance of the writings of the two last and most eminent of the cosmogonists, Leibnitz and Buffon, in the same year during the middle of the last century, the author proceeds in most interesting manner to describe the life and work of the hitherto little recognized Guettard (1715–1786), who, by his brilliant researches in many lines, may be truly called one of the founders of modern geology. To Guettard we owe the first practical attempt to construct geological maps by depicting the superficial distribution of mineral substances. It is doubtful, however, if he had very definite ideas regarding the sequence of formations or of geological structure. His map of western Europe, so far as it relates to the areas of his own observations in France, coincides in a broad way with the modern conception of the distribution of the stratigraphical series, although often erroneously grouping younger with older deposits in his 'bands.' Guettard's contributions in the field of paleontology are also of much significance. He recognized the importance of fossils in geological research, and published many large and elaborate memoirs in which numerous forms are figured and described. He was the first to recognize *trilobites*. The excellence of his descriptions and drawings entitle him to rank according to the author as 'the first great leader of the paleontological school of France.' His memoir, 'On the Accidents that have befallen Fossil Shells compared with those which are found to happen to Shells now living in the Sea,' which appeared in 1765, is regarded as unquestionably one of the most illustrious in the literature of geology, as it introduces a natural explanation for the phenomena of organic remains entombed in the rocks.

To the field of physiographic geology his memoir 'On the Degradation of Mountains effected in Our Time by Heavy Rains, Rivers and the Sea' contributed much and must be regarded as one of the classics of that department of the science. No one had elaborated the subject so fully as he at that period.

The recognition by Guettard of the volcanic origin of the mountains of the Auvergne affords one of the most interesting chapters in the whole book. It is one of the curious facts connected with his remarkable career that these views "practically started the Vulcanist camp, and his promulgated tenets regarding basalt became the watchword of the Neptunists." It seems that he was "an indefatigable and accurate observer who, gifted with a keen eye, well-trained powers of observation, and much originality of mind, opened up new paths in a number of fields which have since been fruitfully cultivated, but who rigidly abstained from theory or speculation."

In the *second* lecture the author discusses the rise of volcanic geology as shown by the work of Desmarest, and also the beginning of geological travel by Pallas and de Saussure. To Desmarest (1725–1815), a public official and astute scientific observer, we owe a further elucidation of the geology of the classic volcanic district of the Auvergne, which had been the scene of so much of Guettard's labors. Although Guettard had observed the general volcanic character of the district, it was Desmarest who, in great detail, traced out the disposition of these various rocks and others, unrecog-

nized by his predecessors, and who endeavored to establish a system of succession among them. This led him to a study of the denudation which the several lava streams had suffered, and thus to the most comprehensive statement of the effects of erosive action based upon concrete examples which had up to that time appeared. One of the most important conclusions of Desmarest's investigations in the Auvergne was the recognition that basalt was of eruptive origin, although he found few supporters for his views and did not enter later into the prolonged discussion which arose upon the subject. His map of the Auvergne elaborated in great detail, although unpublished at the time of his death, may still be regarded as his greatest contribution to geology, and was certainly far in advance of any other attempt at the cartographic representation of geological phenomena of its day.

Desmarest also contributed four massive volumes upon Géographie Physique in the famous Encyclopédie Méthodique, and had not completed the last at the time of his death in his ninetieth year. Cuvier, in his biographical sketch of him, says: "The Academy of Sciences saw in him, as it were, the monument of a bygone age, one of those old philosophers, now too few, who, occupied only with science, did not waste themselves in the ambitions of the world, nor in rambling through too wide a range of study, men more envied than imitated."

A factor which added much to the advance in scientific thought of last century was the rise of the spirit of scientific travel. To Pallas (1741–1811), who spent six years, from 1768 on, at the head of a scientific expedition commissioned by Empress Catherine II., we owe much important geological information regarding a portion of the world then but little known. His study of the Ural chain led to his attempt to classify the rocks of mountain areas, the chief value of his observations lying "in his clear recognition of a geological sequence in passing from the center to the outside of a mountain chain. He saw that the oldest portions were to be found along the axis of the chain, and the youngest on the lower ground on either side." One of the geological questions which especially occupied his attention was the occurrence of the remains of the fossil elephant, rhinoceros and buffalo throughout the whole vast basin of Siberia, between the Ural and Altai mountains.

Few men have better claim to be regarded among the founders of geology than de Saussure (1740–1799), who was the first to arouse the modern spirit of mountaineering, and whose indefatigable travels throughout the high Alps contributed so largely to the stock of ascertained fact which was so useful as a basis for theoretical speculation. To de Saussure we owe the first use of the terms geology and geologist, while his experiments upon the fusion of rocks, although only negative results were obtained, are especially interesting, as they mark the earliest beginnings of experimental geology.

The *third* lecture deals with the history of the doctrine of geological succession, and the influence of Wernerianism upon the geological thought of the day. Lehmann, Fuchsel and Werner more than any others during the latter half of the last century advanced the ideas of geological succession. Lehmann (died 1767) published, in 1756, the first treatise in which a definite attempt is made at a chronological classification of the rocks of the earth's crust. He recognized, from a study of the rocks of the Harz and Erzgebirge, three major orders which became the Primitive, Secondary and Alluvial divisions of the proposed classification. His profiles of the succession of strata showed, according to the author, 'a remarkable grasp of some of the essential features of tectonic geology.' Contemporary

with Lehmann was Fuchsel (1722–1773), who in 1762 published one of the most remarkable works, with map and sections, which had 'up to that time been devoted to the description of the actual structure and history of the earth.' 'He recognized as clearly as Lehmann, and with more accuracy of detail, the sequence of stratified rocks,' and considered that 'the changes which the earth had undergone were of no abnormal kind.' In divining with singular sagacity 'that a continuous series of strata of the same composition constitutes a formation, or the record of a certain epoch in the history of the globe,' he anticipated, according to the author, 'a doctrine which afterward took a prominent place in the system of Werner.'

The most notable figure in the mineralogical and geological arena during the last quarter of the last century and the early years of this was Werner (1749–1817), who, chiefly by the vast influence of 'his personal gifts and character,' wielded an overmastering power upon the geological opinions of the time. Appointed professor at twenty-five in the Mining Academy of Freiberg, he gradually, by the brilliancy of his teaching, drew about him an enthusiastic body of pupils from all portions of the civilized world, and raised the local mining school into the position of a great university. "No teacher of geological science," says Geikie, "either before or since has approached Werner in the extent of his personal influence or in the breadth of his contemporary fame." His most distinguishing quality, he states further, was 'his overmastering sense of orderliness and method,' which made his contributions to the then half chaotic science of mineralogy of vast significance, although he wholly ignored crystalline form in his classification. In the study of the earth, for which he and his adherents used the term geognosy, he endeavored to apply the same precision, and laid down doctrines which he dogmatically applied, although there was generally no basis for them in observed fact. He adopted the idea that "the whole globe had once been surrounded with an ocean of water, at least as deep as the mountains are high, and he believed that from this ocean there were deposited by chemical precipitation the solid rocks which now form most of the dry land." His order of sequence, taken to a considerable extent from Lehmann and Fuchsel, was developed into a system of his own. He believed basalt and other eruptive rocks to be of aqueous origin, and all volcanic activity modern phenomena, produced by vast repositories of inflammable matter.

The greatest service which Werner rendered to the cause of geological science, according to the author, was the enthusiasm he inspired in so many capable men. Among the most distinguished of Werner's pupils were d'Aubuisson (1769–1819) and von Buch (1774–1853), who, although loyal to their master, gradually became convinced of the fallacy of many of his views, and finally practically abandoned them altogether. Curiously, they were led to these conclusions largely from a study of the district of the Auvergne, where in previous years Guettard and Desmarest had done such valuable work for the cause of geological science. Von Buch especially became one of the most prominent figures in European geology. He traveled widely, and the result of his investigations greatly enriched geological literature. In 1824 he brought out a geological map of Germany in forty-two sheets, while his contributions to the science covered nearly every branch of geological research.

The *fourth* lecture is devoted to the consideration of a very different school of geology than that described in the previous chapter. It had for a time far fewer supporters than the Neptunist System of

Werner, although in the end largely supplanting the latter. This opposing school had as its chief representative the Scotch scientist Hutton (1726–1797), who, although never wielding the personal influence of Werner, slowly developed, by actual observation, a system of geological thought that forms the basis of much of modern geology. Hutton himself published but little regarding his ideas. His chief work, entitled 'Theory of the Earth, with Proofs and Illustrations,' appeared in 1795; but Playfair (1748–1819), his friend, has given us, in his 'Illustrations of the Huttonian Theory of the Earth,' an admirable exposition of his views. Hutton, unlike Werner, had 'no preconceived theory about the origin of rocks,' but considered that 'the past theory of our globe must be explained by what can be seen to be happening now.' He observed that the greater part of the land consists 'of compacted sediment which had been worn away from some pre-existing continent, and had been spread out in strata over the bed of the sea,' and that the strata had often become 'inclined, sometimes placed on end or even stupendously contorted and ruptured.' Recognizing as of fundamental importance the internal high temperature of the globe, of which volcanoes are one of the proofs, he distinguished three types of eruptive rock—whinstone, porphyry and granite—which he considered had been intruded from below among the rocks with which they are now found associated. Hutton, to be sure, drew no distinction between mineral veins and dykes, referring them all to intrusive origin and even regarded the flint concretions of the Chalk to be of similar origin.

We find also in the Huttonian theory practically 'the whole of the modern doctrine of earth sculpture,' while there is also 'the germ of the Lyellian theory of metamorphism.' Even the modern conception of glacial action is foreshadowed in the recognition of the potency of glaciers in the transport of detritus. Hutton 'rigorously guarded himself against the admission of any principle which could not be founded on observation,' and never permitted himself to make any assumptions. It is said of him that 'he was a man absorbed in the investigation of nature to whom personal renown was a matter of utter indifference.'

Among Hutton's friends was Hall (1761–1830), to whom we owe 'the establishment of experimental research as a branch of geological investigation.' His experiments upon the fusion of rocks, in which he showed the effects of the rate of cooling upon texture, are of much interest in the history of volcanic geology. Other experiments upon the effect of pressure in modifying the influence of heat, and his machine for contorting layers of clay, are hardly less significant.

For a time the Huttonian views in Scotland received a setback by the appointment of Jameson (1774–1854), a pupil of Werner, to the professorship of geology at Edinburgh, but upon the death of the great master, in 1817, his views, already opposed openly even by some of his pupils, rapidly declined in favor, and the old controversy between the Neptunist and Vulcanist gradually disappeared.

The *fifth* lecture is devoted to a consideration of the rise of stratigraphical geology, as shown by the work of Giraud-Soulavie, Cuvier, Brongniart and D'Omalius d'Halloy in France, and Michell and William Smith in England. To Giraud-Soulavie (1752–1813) 'the merit must be assigned,' according to the author, 'of having planted the first seeds from which the magnificent growth of stratigraphical geology in France has sprung.' In a series of volumes upon the natural history of southern France, of which the first two appeared in 1780, he described the calcareous mountains of the Vivarais

and divided the limestones into five epochs or ages, the strata in each of which are marked by a distinct assemblage of fossil shells. He thought, however, "that the most ancient deposits had been accumulated at the highest levels, when the sea covered the whole region, and that, as the waters sank, successively younger formations were laid down at lower and lower levels," and "he felt confident that if the facts observed by him in the Vivarais were confirmed in other regions a historical chronology of fossil and living organisms would be established on a basis of incontestable truth."

Cuvier (1769–1832) and Brongniart (1770–1847) together studied in much detail the Tertiary formations of the Paris basin. They demonstrated in this area 'the use of fossils for the determination of geological chronology and they paved the way for the enormous advances which have since been made in that department of our science.' They brought forward clearly the evidence for 'a definite succession among the strata and the distinction of the organic remains contained in them.' Cuvier had already shown that the fossil elephant found near Paris belonged to a different species from either of the living forms, and by further research reconstructed the skeletons of other types, which enabled him to announce 'the important conclusion that the globe was once peopled by invertebrate animals which, in the course of the revolutions of its surface, have entirely disappeared.' The work of Cuvier and Brongniart upon the Tertiary formations has been but little altered, although greatly elaborated. The broad outlines sketched by them remain as true now as they were when first traced by them early in the century.

D'Omalius d'Halloy extended the work of his predecessors among the Tertiary formations, but, what is of more interest, 'recognized the leading subdivisions of the Cretaceous series and actually showed the extent of the system upon a map. This map is regarded as the first attempt to construct a true geological map of a large tract of France,' which was something more than 'a mere chart of the surface rocks.' It was provided with a horizontal section showing the structural relations of the formations.

In England, Michell is regarded as the first to present anything like a clear idea of stratigraphical sequence, a table giving the broad features of the succession of strata from the Coal Measures of Yorkshire up to the Chalk, having been drawn up by him about 1788 or 1789. Geikie very clearly points out, however, that "the establishment of stratigraphy in England, and of the stratigraphical sequence of the Secondary, or at least of the Jurassic, rocks for all the rest of Europe, was the work of William Smith," a land surveyor, usually known as the 'Father of English Geology.' "No more interesting chapter in scientific annals can be found," according to the author, "than that which traces the progress of this remarkable man, who, amidst endless obstacles and hindrances, clung to the idea which had early taken shape in his mind, and who lived to see that idea universally accepted as the guiding principle in the investigation of the geological structure, not of England only, but of Europe and of the globe." Smith made no attempt to publish his results, although he accumulated a vast store of notes upon his observations during his journeys in the pursuit of his profession. His ideas gradually became widely known, and a card of English strata from the Coal to the Chalk, drawn up in 1799, though not actually published, obtained wide publicity. His geological map of England and Wales with part of Scotland, in fifteen sheets, regarded as one of the great classics of geological cartography, and upon which he had been at work for many years, was not

published until 1815. The appearance of this map marked 'a distinct epoch in stratigraphical geology, for from that time some of what are now the most familiar terms in geological nomenclature passed into common use.' Smith also published geological maps, on a larger scale, of the English counties and a series of horizontal sections across different parts of England.

The *sixth* and last lecture deals with the further development of stratigraphical geology along lines laid down by Smith and his distinguished contemporaries, who had applied the criteria derived from fossils with such success. Smith's researches, as we have seen, did not include rocks older than the Coal Measures. The great mass of earlier strata known in the old classification as Greywacke, or Transition, rocks were regarded in their generally disturbed and poorly fossiliferous condition to be beyond interpretation by the principles of Cuvier, Brongniart and Smith, until Murchison and Sedgwick, for the most part, 'working independently of each other in Wales and in the border counties of England,' succeeded in establishing a definite order among the oldest fossiliferous formations, thus adding the Devonian, Silurian and Cambrian chapters to the geological record.

Murchison (1792–1871), after several years of investigation of the Secondary rocks of England and the Continent, and some preliminary work with Sedgwick upon the old rocks of the northern counties of England, began in 1831 in Wales and the adjoining counties of England his epoch-making study of the strata below the Old Red Sandstone. Starting with that already known and easily recognizable horizon he established a series of underlying divisions which he found to be characterized by peculiar fossils. To this assemblage of formations, which he divided into an Upper and a Lower series, he gave the name of Silurian System. He recognized its conformity to the Old Red Sandstone, but wrongly thought it to rest unconformably upon the older series of greywacke. Murchison also worked out the lithological character of these old rocks, observing eruptive materials among them, some of which he clearly saw were intrusives, while others he recognized to be lavas and ashes. His first communication upon this subject was made to the Geological Society of London in 1831, his great book, 'The Silurian System,' appearing in 1838. The author tells us that even before the advent of this volume his remarkable results had become widely known and 'within a few years the Silurian System was found to be developed in all parts of the world,' Murchison's work furnishing the key to its interpretation.

Sedgwick (1785–1873), almost from the very beginning of his career, devoted his energies to the ancient rocks, his earlier publications, however, showing strong leanings to the Wernerian school. He soon parted with these views and early came to a true perception of geological principles which he applied in a study of the older formations of northern England. The author tells us that though fossils had been found in the rocks Sedgwick did not at first make use of them for purposes of stratigraphical classification, but ascertained the succession of the great groups of strata upon lithological grounds alone. He, as well as Murchison, recognized volcanic rocks to form part of the greywacke rocks of North Wales and soon 'succeeded in disentangling their structure and ascertained the general sequence of their principal subdivisions.' At this period, however, his investigations were of far less significance in the field of general stratigraphy than Murchison's, since he had not determined the relation of his rocks to any well recognized horizon and had made no use of fossils for correlative purposes. Later investigations showed that the upper part of what Sedgwick termed the Cambrian system con-

tained the same organic remains as the Lower Silurian formations defined by Murchison, and thus arose a permanent misunderstanding between these two old friends and leaders in English geological thought.

While this dispute was in progress Barrande made his remarkable investigations in the Bohemian basin, where he not only recognized the equivalents of Murchison's Upper and Lower Silurian, but also found a still older group of strata containing forms similar to those occurring in Sedgwick's Cambrian system. To the latter fauna he gave the name of First or Primordial fauna. The consensus of geological opinion, on the grounds of priority, to-day regards as Lower Silurian the Upper Cambrian of Sedgwick. Sedgwick's classification, however, in these old and disturbed rocks has proved of vast importance in the elucidation of the ancient sediments, and the succession of strata observed by him has continued with hardly a modification to the present day.

A no less important work pursued by Sedgwick and Murchison together in the days before their estrangement was the determination of the Devonian. Its reference in the absence of stratigraphical data to a position between the Silurian and Cambrian was based mainly upon the paleontological work of Lonsdale, who pointed out that the fossils in its lower portions showed an affinity to the Silurian while those in its upper parts were closely allied to the Carboniferous faunas.

The pre-Cambrian rocks now remained to be studied and deciphered. The paleontological criteria were no longer available and many difficulties presented themselves. "The first memorable onward step," according to Geikie, "was taken in North America by Logan (1798–1875)." Some study had already been given to these old rocks, but Logan was the first to attempt to establish a chronological sequence among them. To him we owe the names Laurentian and Huronian, and although his results have been much modified by subsequent observers his work marks a distinct advance in this field of stratigraphical geology.

The first recognition of the wide significance of glaciers as geological factors of more than local importance must be accorded to Agassiz (1807–1873). He was the first to offer a satisfactory explanation for the so-called erratics, which were found distributed over the Swiss plain and the flanks of the Jura mountains. Contrary to the preconceived notions of the day, he held that the Alpine ice once extended over the area and that it was an explanation of a former period of extreme cold. His further researches in England, where he found similar phenomena, convinced him that the great extension of ice was connected with the last great geological change on the surface of the globe. These teachings of Agassiz, which to-day, in all their essential elements, have been generally accepted, place his name, according to the author, as that of 'the true founder of glacial geology.'

The attempts at geological classification upon lithological grounds, which had been pushed to such an extreme by Werner and his followers, greatly declined after the marvelous impetus which the study of organic remains brought to the science of geology. But the investigation of rocks in their mineralogical aspects was not to be permanently abandoned. The invention of the famous prisms of Iceland spar by Nicol and the cutting of thin sections introduced a new element into geological investigation, but it was not until Sorley extended this method by the more systematic examination of thin sections that microscopical petrography became recognized in the field of geological research. The publication, in 1858, of his memoir 'On the Microscopic Structure of Crystals' marks one of the most prominent epochs in modern geology. There was at first much opposition to this method

of investigation, but it soon had many devoted followers who have done much to advance the science, among the more important being Zirkel, Rosenbusch, Fouqué and Michel Levy.

There yet remain two illustrious names to be mentioned among the founders of geology. They are Charles Lyell and Charles Darwin. Lyell (1792–1875), who exercised a profound influence on the geology of his time, adopted the principles of Hutton, and with marvelous industry collected a vast store of facts in support of the doctrine that 'the present is the key to the past.' He pushed the Huttonian doctrine to its logical conclusion and became the great leader of uniformitarianism, a creed which, according to the author, 'grew to be almost universal in England during his life, but which never made much way in the rest of Europe.' Lyell's 'Principles of Geology' must certainly be regarded as one of the classics of our science. To Lyell, in conjunction with Deshayes, we owe the classification of the Tertiary into Eocene, Miocene and Pliocene, upon the basis of the proportion of living species of shells. Lyell was not so much an investigator as 'a critic and exponent of the researches of his contemporaries.' Ramsey said of him, "We collect the data, and Lyell teaches us to comprehend the meaning of them."

Darwin (1809–1882) did much, not only by his contributions to the literature of geology, but in the introduction of the doctrine with which his name is associated, to revolutionize the geological thought of his time. His demonstration of the imperfection of the geological record and the great antiquity of the earth's crust came, according to the author, 'as a kind of surprise and awakening.'

In concluding the lectures the author calls attention to three prominent facts: first, that but three of the men considered, Werner, Sedgwick and Logan, could be called professional geologists, the others being either men of leisure, as Hutton, Hall, de Saussure, von Buch, Lyell and Darwin, or professionally engaged in other pursuits, as was the case of the great majority; second, that geology affords 'some conspicuous example of the length of time that may elapse before a fecund idea comes to germinate and bear fruit,' as, for instance, the length of time taken for the true principles of stratigraphical geology to become recognized; and third, that 'one important lesson to be learnt from a review of the early history of geology is the absolute necessity of avoiding dogmatism' the examples of the Wernerian catastrophist and uniformitarian schools being cited.

In endeavoring to give a somewhat comprehensive review of this latest important work of Sir Archibald Geikie it has been impossible to bring out clearly the delightful biographical and personal touches which so charm the reader. In the summary of the work which I have given it has been my endeavor to use, so far as possible, the phrases and happy expressions with which the book so richly abounds. The volume is one of much significance to the student of geology, as it for the first time presents to English readers anything like a satisfactory statement of the development of geology. Many of the men to whom we owe so much regarding our modern views of the science, and whose work has been but little considered by recent writers, are brought before us in their true proportions. The book must take high rank among the many other masterpieces of the distinguished author.

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CHARACTERS, CONGENITAL AND ACQUIRED.

II.

ACQUIRED physical characters (properly so termed) may involve not only quantitative changes, which alone we have as yet considered, but qualitative changes also.

Here, again, a wide field for investigation presents itself. For example, in man exercise does not merely cause a muscle to increase in size; it occasions besides, as in athletes after training, an increase in efficiency (*i. e.*, in the power and duration of contraction), which is greatly out of proportion to the increase in size. Intermittent friction or heat or other irritant (*e. g.*, chemical) not merely causes the skin to thicken, as in corns and callosities; it renders it denser also. Again, stimulation (that is use) may result in change which is wholly qualitative. Thus eyes which, when unaccustomed to the task, are rendered sore by the continued scrutiny of small objects (*e. g.*, print, as in the case of an adult learner) may by practice be trained, without apparent physical change, to endure this proceeding without damage. Most of these qualitative changes are best studied in connection with mind, but there is one series, of vast importance to the higher animals, and especially to man, which is entirely physical, and to which I may, in conclusion of this part of my subject, draw attention. I allude to the power which Natural Selection has developed in high animals of acquiring capabilities of resisting various poisons, particularly those offensive and defensive poisons (toxins) which are secreted by various plants and animals. Thus men acquire greatly increased powers of 'tolerating' nicotine and opium, which are *toxins* secreted respectively by the tobacco and poppy plants to protect them from organisms to which they are liable to fall a prey. Thus also man may acquire the power of 'tolerating' the poisons of various species of parasitic micro-organisms which afflict him and the higher animals, and which are the cause of that great class of diseases known as zymotic. These toxins, also, are defensive products by means of which the pathogenic organisms ward off the attacks of the phagocytes in the blood of the host by which they are liable to be destroyed.* When the phagocytes, through experience of the toxin, acquire the power of tolerating it they destroy the microbes whereby *acquired immunity* is achieved, as in chicken-pox, measles, scarlatina, small-pox, typhoid, etc. Without this power of acquiring immunity (temporary or permanent) there could be no recovery from such a disease as measles, for instance; and therefore, since, unlike malaria, for instance, most of these diseases pass from one infected person to another, and are for that reason diseases of comparatively dense populations. Without this power of acquiring immunity no dense populations could exist. In other words, if this power of acquiring immunity had not been evolved in man, civilization would have been impossible.

I have said that the power of acquiring physical traits does not exist among low animals, or, if it exists, does so in proportion as they are lowly placed in the scale of life, to an extent very small as compared to its development among high animals. If I am right as to this, low animals (*e. g.*, invertebrates) should be incapable or little capable of acquiring immunity against zymotic disease. I am not aware, however, that any observations on the subject have been made.

I dare say that many who read the foregoing will be inclined to dispute the facts and inferences put forward, and to urge, for instance, that I have not established any proof, nor even brought forward convincing evidence, of the truth of my assertion that low animals are incapable, or less capable than high animals, of acquiring physical characters. There is, in truth, no literature to which I can appeal, for the question is

* Vide *The Present Evolution of Man*, pp. 199-32 (London, Chapman & Hall, 1896), and an 'Address on Acquired Immunity,' by the author, *Lancet*, September 11, 1897.

entirely new; and therefore, also, so far as I am aware, no experiments directly bearing on it have been made. Moreover, in the highest animals all acquired physical characters are merely extensions of previously existing inborn characters. Thus the limb of an infant, which is compounded, as we may suppose, almost entirely of that which is inborn, grows under the influence of exercise and use into an adult limb. There is a sharp dividing line, but we cannot perceive it; and, therefore, as regards the infant's limb, we cannot as yet say where the inborn ends and the acquired begins. But in mind, which we have next to consider, the case is often very different. There the inborn is often sharply marked off from the acquired, and we shall find it emphatically true that low animals are infinitely less capable of acquiring mental traits than high animals. Whence, reasoning by analogy, we may, with some confidence, assert that if, as regards mind, the statement is true, in the absence of evidence to the contrary, it is probably true also as regards the physical parts.

Mind, doubtless, owes its origin to movement—to the necessity for coördinated movement in the various parts of the complex cell-community which we call a multicellular animal. Neither mind nor nervous tissue, the organ of mind, exists in plants, among which there is little or no movement. So, also, low in the animal scale, as among sponges, in which cells are not coördinated to perform movements *en masse*, there is no mind nor any need for it. Higher in the scale, as among Cœlenterates, in which masses of the cells combine to perform macroscopic movements, we begin to find traces of nerve tissue, but as yet there is, so far as we are aware, no mind. All movement apparently is purely reflex. Yet higher in the scale, as among the Mollusca in which the increasing complexity of the environment necessitates increasingly complex coördinated movements of masses of the cell-community, the nervous mechanism by means of which this coördination is carried out becomes still more developed and complex, and mind apparently dawns. So far as we know, consciousness then first appears, and with consciousness the rudiments of instinct.

I have elsewhere defined instinct as "the faculty which is concerned in the conscious adaptation of means to ends by virtue of inborn inherited knowledge and ways of thinking and acting."* In other words, instinct depends wholly on congenital characters, and not in the least on those which are acquired. This definition of instinct is far different from those which have hitherto found acceptance, but I think on consideration it will be found that it more correctly describes what we commonly mean by the term than any other hitherto put forth. By instinctive action do we not mean action which is independent of all previous experience and therefore of acquirement? When an insect secures its proper food in the proper way, spins a cocoon, mates with an individual of the opposite sex, or lays its eggs, with fit provision for the future, in an appropriate place, does it not act solely by virtue of inborn inherited knowledge and ways of thinking and acting, and, since it is unguided by experience, not in the least by virtue of knowledge and ways of thinking and acting which are acquired? To the mind of every naturalist will at once occur innumerable instances of actions, some of them extremely complex and elaborate, performed by insects and other comparatively low animals, in which experience can play no part; in other words, which are wholly independent of acquired knowledge and ways of thinking and acting. By means of instincts animals are enabled to place themselves in harmony with an environment infinitely more complex than

* *The Present Evolution of Man*, p. 137.

that to which reflex action alone can adapt them. The element of consciousness and its outcome, choice, are introduced. The conscious animal, unlike the unconscious, is enabled to choose between two or more courses, to which two or more instincts impel him. Thus the male spider approaches the gigantic female, guided by both the mating and life-preserving instincts, and all the complications of his subsequent conduct are due to his power of choice between two or more courses.

Higher in the scale, concurrently with the evolution of the power of acquiring physical traits (properly so called), is evolved the power of acquiring mental traits. It increases in successively higher animals, and at length, in the highest animals, becomes of such importance that it overshadows and replaces instinct, which, since it no longer holds a commanding place as a factor in survival, undergoes great retrogression.* If I can make my readers grasp all that is implied in the above I think they will admit the vast importance I have claimed for my subject—an importance which is not only from the standpoint of the man of science, but from many other standpoints, such as those of the moralist, the sociologist, the statesman, the philanthropist, the physician and others as well.

Let us contrast two animals which, for convenience, we may regard as at opposite ends of the scale, the dragon-fly and man. Tennyson's beautiful lines occur to me. I quote from memory:

> To-day I saw the dragon-fly
> Ceme from the wells where he did lie.
> An inner impulse rent the veil
> Of his old husk. From head to tail
> Came out clear plates of sapphire mail.
> He dried his wings; like gauze they grew.
> O'er crofts and pastures, wet with dew,
> A living flash of light he flew.

Physically, like other low animals, the dragon-fly does not develop in response to exercises and use, or, if he does, it is to a very small extent compared to higher animals. Natural selection has nicely coördinated his structures, but has not evolved in them (at least to an appreciable extent) the power of developing further and in the right direction during the changing stress of circumstances. For example, his principal organs of locomotion, his wings and the structures which subserve them, are certainly wholly inborn. Mentally, at the beginning of each stage of his existence he is able to coördinate his muscles perfectly, and thus at the beginning of each stage his locomotion is apparently as good as at the end. Both in the water and in the air he knows what food to seek, and what enemies to avoid, and how to do so. At the fit time, impelled by an inborn impulse, he leaves the water, and, having undergone his last metamorphosis, is able, at once, to adapt himself to life in an entirely new environment, where the medium in which he exists, his mode of locomotion, his prey and his enemies are different, and where his procreating instinct comes into activity. But experience teaches him little or nothing; he cannot acquire mental traits; in other words, *he has little or no memory.*

Far different is the case with man. We have seen how much he acquires physically, so that the adult differs from the infant mainly in traits which he acquires, not in those which are inborn. Mentally, his powers of acquirement are even more remarkable; and, therefore, even more as regards his mental characters than as regards his physical characters, the adult differs

*Just as physical characters (*e. g.*, limbs of serpent, lost digits of horse, eye of proteus) undergo retrogression through atavism, wherebymore and more remote ancestral conditions are reverted to till that remote ancestral character is reverted to, when the character did not exist. Vide *The Present Evolution of Man*, pp. 18–30.

from the infant in that which is acquired, not in that which is inborn. At birth the infant's mind is a blank; he can coördinate only a very few groups of muscles (*e. g.*, the breathing, sucking and defæcating groups), and in these the coördination is never very delicate and elaborate. He knows nothing of his environment; he cannot, as can the dragon-fly, instinctively adapt himself to it. But gradually as his body develops under the influence of use and exercise, his mind develops also under the influence of experience, and the blank left by the retrogression of instinct is filled and more than filled by acquired knowledge and ways of thinking and acting. Slowly and painfully the infant *learns* to coördinate his different groups of muscles till at length he can perform such complex acts as speaking, writing and walking in which the coördination is exceedingly delicate and elaborate.* Much, very much, besides the power of coördinating his muscles is acquired by man. For instance, all the vast contents of his memory and all that arises out of memory are, of course, acquired. Here, again, all that is inborn is *the power of acquiring the contents of the memory*. I have elsewhere defined reason as 'the faculty which is concerned in the conscious adaptation of means to ends by virtue of acquired non-inherited knowledge and ways of thinking and acting.'* Compare, for instance, the construction of a cocoon by a caterpillar, or the first web spinning of a spider, to the construction of a house or the weaving of a net by a man. In the absolute absence of experience the caterpillar and the spider plainly act by virtue of inborn knowledge and ways of thinking and acting, in other words, by instinct; the man, on the other hand, as plainly acts by virtue of acquired knowledge and ways of thinking and acting, in other words, by reason.† In fact, so vast a part does the

*It has been denied (*e. g.*, *Lancet*, May 1, 22 and 29, 1897) that speech and bipedal progression are acquired. The denial arises from that habit of thinking in abstract terms which is the bane of many writers. One cannot speak without words, and every word is acquired and, therefore, speech itself is acquired. For instance, no one is born with the knowledge of the word 'brick.' Again, this sound (brick), like all others in a language, is produced by a particular and very delicate and complex coördination of the speech muscles, different from what is required to reproduce any other sound. The child *learns* to make this coördination, just as in after life he may learn to make that coördination from which results a foreign word, or that coördination of a different set of muscles from which results a written word. Again, a child *learns* to walk in just as true a sense as afterwards he may learn to bicycle. Speech and bipedal progression are common to the whole human race, and, therefore, they are invariably regarded as inborn characters. Writing and bicycling are not common to the human race, and, therefore, they are regarded as acquired; but very plainly the former are as much acquired as the latter. What alone is inborn is the *power of acquiring* speech and bipedal progression and vastly more besides.

* *The Present Evolution of Man*, p. 138.

† The terms 'instinct' and 'reason' are used very loosely even by scientific writers, the meaning of the former often being too much extended, while that of the latter is too much restricted. Thus, it is said, that we instinctively like or dislike this or that object, *e. g.*, man, implying thereby that we do so in the absence of experience. But the new-born infant (unlike the new-hatched fish) has no such instinctive like or dislike; his subsequent likings or dislikings arise as a result of experience, whether such experience remains as a recognizable part of consciousness or not. Again, actions which depend on acquirement, but which have become automatic from frequent repetition, are often termed instinctive, owing to the instinct-like absence of mental effort with which they are ultimately performed (*e. g.*, bipedal progression; vide *Present Evolution of Man*, pp. 144–5). On the other hand, the term rational is often restricted to such actions as conspicuously result from a correct chain of inferences, or to such as are not performed under the influence of violent emotion. For example, when an angry man embarks on foolish litigation we term his action irrational, thus expressly excluding it from the category of rational actions. But his action is certainly not reflex, nor, as certainly, is it instinctive, and, therefore, if we group all actions under the headings of reflex, instinctive and rational this action can belong to the last group only.

acquired factor play in all that is mental in man, that I have been unable to discover any action in him which is purely instinctive. Purely reflex actions he has in plenty, as, for instance, the movements of the various hollow viscera; but of the few instincts which survive in him (*e. g.*, parental and sexual love) none apparently are gratified without the aid of rational action. Consider, for instance, how greatly the instinctive appreciation of female beauty is modified by the acquired factor; there are savage tribes who mutilate, to render beautiful as they think, the faces of their women to a frightful degree.* Consider, again, how much there is rational (*e. g.*, the coordination of her muscles) in the mother's care of her offspring.

As in the case of physical characters, no systematic attempt has been hitherto made to differentiate between the mentally acquired and the inborn. As a result, much confusion and inaccurate thinking is manifest in writings, scientific and otherwise. I propose to deal with these to some extent presently; but first it would be interesting to trace, in however slight a manner, the evolution of the power of acquiring mental traits in animals. But, even before doing this, one other digression I may permit myself, since it has an important bearing on much that follows. It has been maintained that acquired characters, mental and physical, are transmissible. I will not here pause to consider whether such characters as I have ventured to denominate 'enforced,' nor whether such characters as result from the complete or partial reproduction of lost parts, are transmissible. The battle has been fought in countless publications, and I do not know that I have now anything very new or original to add; but I should like to say a little concerning the alleged transmissibility of such characters as result from use or experience, for instance, the acquired enlargement of the blacksmith's muscle through use, or the mental change involved in the acquirement of a knowledge of mathematics through experience. Characters like these are held by a section of biologists to be transmissible, in part at least. But when a parent acquires such characters they reappear in the child only in response to stimulation similar to that which caused them to arise in the parent. For instance, without such stimulation the child gets neither the enlarged muscles nor the knowledge of mathematics; in fact, the child must in all cases, acquire such characters afresh; from which it is plain that that which is acquired by the parent does not become inborn in the child.

It may, however, be maintained by Neo-Lamarckians that stimulation causes not only the acquirement of a character, but increases also the power of acquiring it, and that it is this increase in the parent which is transmitted to the child, and which renders more easy the acquirement of the character by the latter. But there is no tittle of evidence showing that the stimulation which results in the acquirement of a character (mental or physical) causes also an increase in the power of acquiring it. The converse is in fact true; the infant's power of acquiring characters, mental and physical, is immense, and to it is mainly owing the development he undergoes in his passage from infancy to old age; but this power steadily declines in his long stimulated parts (mental and physical), till in the old man it is reduced to a minimum and tends to vanish. Clearly, then, as regards such characters as result from use and experience there can be no transmission to the child; therefore, as regards them, evolution must have proceeded

* Our women have worn crinolines and chignons and still wear earrings and corsets.

wholly on lines of Natural Selection. Moreover, instincts (and such physical characters as are analogous to instincts, *i. e.*, inborn physical parts) cannot have resulted from the transmitted effects of experience and use, since they do not increase under such stimulation. There is, for instance, no reason to suppose that any instinct is sharpened by use, or, in other words, by experience. In fact, it would be a contradiction in terms to suppose that it is, since, if my definitions are right, all that is acquired pertains to reason, not to instinct. Moreover, did instincts increase under stimulation and were this increase transmissible in however slight a degree, then instincts should be most developed in the highest animals and less in lower animals. The contrary, however, is the fact.*

All acquired mental characters depend, of course, in the last analysis, on memory; and, therefore, an animal which is incapable of acquiring mental characters, and which, therefore, depends wholly on instinct, can have no recollection of past events, nor, as a consequence, any ideas concerning the future; it must live entirely in the present. To this it may be objected, however, that various insects display an instinctive memory, and, for instance, return again and again with food to the nest where they have laid their eggs. If, however, my definitions are correct these returns are not due to memory, but to an impulse (similar to that which causes them in the absence of experience to know a fit spot wherein to lay their eggs), which causes them again and again to return to this particular place, quite independently of any recollection of having been there before.† It has even been denied that animals so high in the scale as fish possess a memory (the power of acquiring mental characters).* The seat of the memory has been held to be the cortex of the brain, and fish alone of all vertebrata have no cortex.† I think, however, there can be no doubt that fish have some power of acquiring mental traits, since trout in a much-fished stream soon grow more wary. Indeed, memory may be detected in animals much lower than the fish. Even so low in the scale as the oyster is a rudimentary capacity for mental acquirement observable, for "even the headless oyster seems to profit from experience, for Dicquemase asserts that oysters taken from a depth never uncovered by the sea open their shells, lose the water within and perish; but oysters taken from the same place and depth, if kept in reservoirs, where they are occasionally left uncovered for a short time and are otherwise incommoded, learn to keep their shells shut, and then live for a much longer time when taken out of the water."‡

As I have already said, speaking in general terms, the higher placed an animal is in the scale of life the greater is its power of acquiring mental characters, as will be apparent presently and as might have been expected; but it is also true that the higher species of a lower class or order often exhibit greater capacities for acquirement than

* It follows, then, from the above, that, except as regards the effects of mutilations, which I do not here consider, evolution can have proceeded only on the lines of inborn variations.

† Compare the swiftly forgotten alarm of a house-fly with the more and more permanent fear of successively higher creatures.

* Vide *Lancet*, January 23, 1897.

† And, therefore, in choosing the dragon-fly as an animal conspicuously lacking in acquired mental traits to contrast with man, in whom they are conspicuously abundant, I have not intended to imply that the former is quite incapable of acquiring mental characters, only that it is so little capable of acquiring them that it forms an admirable foil to man, the animal above all the most capable of such acquirement. I do not *know* that the dragon-fly is quite lacking in this quality, but only that it is so little developed in him that I personally, with my imperfect knowledge, have not been able to detect any traces of it.

‡ 'Animal Intelligence,' by Romanes, pp. 24, 25.

the lower species of a higher class or order. It is even true that some invertebrates exhibit far greater mental receptivity than many vertebrates. Speaking again in general terms, the power of acquiring mental characters is only developed to a considerable extent in such animals as tend their young, and in them it is developed in proportion to the length of time parental care is continued. Furthermore, it is developed to a very great extent only among such animals as not only tend their young for prolonged periods, but also lead gregarious lives. When animals, after laying their eggs, abandon them to chance it is clear in cases where mind (*i. e.*, consciousness and all that results from consciousness) plays a part in securing survival that such mind must be considerably developed from the moment of hatching. Hence it is that in such animals instinct greatly predominates. Moreover, they cannot acquire traits by imitation from their parents, and, therefore, whatever is acquired by the one generation is completely lost to the next; in other words, they have no traditional knowledge, and all that is mental in the individual is either inborn or has been discovered by himself. But when the animal, after birth, is protected for a prolonged period by its parent it is clear that instinct (inborn knowledge and ways of thinking and acting) becomes less necessary for survival, since an opportunity is afforded for acquiring fit knowledge and ways of thinking and acting from the environment, particularly from the parent. It is then possible for knowledge to become traditional, and to be handed down from parent to offspring. When, in addition, such animals lead gregarious existences the individual has the opportunity of acquiring mental characters, not only from the parent, but from other members of the community as well, and then complex mental acquirements have the best chance of being transmitted, instead of being lost. Under such circumstances the power of acquiring useful mental characters becomes a main factor in the struggle for existence, and those individuals that most possess it survive in the greatest numbers; and therefore, concurrently with the growth of knowledge, occurs an evolution of the power of acquiring knowledge and a corresponding retrogression of instinct, which, in the ancestry, was a main factor of survival, but is now no longer so.

I have given the dragon-fly as an example of an active animal which does not tend its young, and in which, therefore, instinct is developed to a high degree. The ant, on the other hand, is an animal which not only tends its young, but also lives in great communities; and we have striking evidence that some species of ants, at least, and probably all of them, are actuated largely by knowledge and motives which are acquired, *i. e.*, by reason, and not by inborn mental characters, *i. e.*, by instinct. Thus enslaved ants, captured as pupæ and educated wholly by their captors, differ markedly from the free members of the species; they have other knowledge and ways of thinking and acting; and the fact that the slaves, in their new homes, so readily adapt themselves to the changed environment, so readily exhibit knowledge and ways of thinking and acting which must be acquired and cannot possibly be instinctive, for the reason that their ancestry can never have been subjected to the influence of a like environment, proves how great a share reason has in all that is mental in them. And since the slaves clearly acquire mental traits which fit them for their duties as servants, it is not unreasonable to suppose that the slave-holders, in like manner, individually acquire the mental traits which fit them for functions as masters, *i. e.* that in them the slave-holding habit is not instinctive, but rational.

The lower vertebrata do not tend their young, which, therefore, are hatched highly endowed with instinct, but with little power of acquiring mental characters. Reptiles, having better developed brains, have greater capacities for acquirement than fish; they can be trained to a much great extent, can learn much more, and have been known to manifest affection for their masters, in which cases the acquired affection has been so strong as to overcome the instinctive dislike. Birds and mammals, like ants, tend their young, which, in proportion to the amount of protection accorded, are born helpless and devoid of instinct, but capable of mental acquirement. Ever, as we rise upwards in the scale, do we find this increasing protection associated with a growing helplessness at birth, and a steadily enlarging capacity for acquirement which finds physical expression in a more and more developed brain, especially of the cerebral portion of it. A partridge at hatching and a fawn at birth are able to coördinate their muscles to a considerable extent, and have many other instincts. The parrot and the pup are very much more helpless, but their capacity for acquirement is greater in proportion. Highest of all, the human infant is born absolutely helpless; it is unable to coördinate all but a very few groups of muscles; its instincts are reduced to a minimum; it cannot even seek the breast; but it is protected with prolonged and tender care, under which its vast powers of acquirement come into play.

Instincts, therefore, have undergone great retrogression in the higher types, but amid this general retrogression three instincts at least have undergone evolution: (1) the parental instinct to protect the offspring; (2) the parental instinct to impart to the offspring the acquired knowledge which subserved the parents' survival; and (3) the instinct which impels the offspring to imitate the parent, and so acquire the physical and the mental traits, the traditional knowledge and ways of thinking and acting, which the latter acquired. This subject is a very interesting one, but my space is limited, and therefore I will not dilate on it, but content myself by instancing such familiar examples as the hen, the cat and the human being in proof of my statements. Each of these animals teaches its young in a different way, and the instinct of the young causes it to imitate the parent and sport in such a manner as to develop (*i. e.*, favor the acquirement of) the physical and mental characters which conduce to the survival of the individual and the race. If it be doubted that animals lower than man have traditional knowledge, which is handed from generation to generation, I have only to instance parrots of New Zealand, which have recently acquired the habit of sheep eating, and the change which soon occurs in the demeanor of the higher animals towards man when he first enters a land where he was previously unknown, *e. g.*, the Galapagos Islands. In such lands lower animals (insects, for instance), if they exhibit alarm on his first appearance, show no increase of it in subsequent generations.

Some of this traditional knowledge, especially when it is of a kind greatly to favor survival, is doubtless of vast antiquity. Of such a nature, if I am right in regarding it as an acquirement, must be the slave-making habit of certain ants, since their very physical structure has been immensely modified by it—not by the *congenital* transmission of acquired characters, but wholly by the transmission and accumulation of such inborn variations as best served the utilization of the acquired character; hence, for instance, the great jaws of *F. rufescens.* In man occur many examples of physical structures modified by the persistent acquirement, in generation after generation during long ages, of particular acquired characters. For example, his whole di-

gestive apparatus has been modified by his acquired habit of cooking or otherwise modifying his food, to which cause may even be attributed the unsoundness of the teeth of civilized man; these, since they are no longer absolutely essential to survival, having undergone retrogression as regards their power of resisting bacteria, etc. His lingual muscles have been modified by his acquired habit of speech. His slowly-acquired habit of bipedal progression has resulted in immense and obvious physical alteration. Even the acquirement of surgical knowledge, at first rudimentary, but now highly advanced, has caused at least one important modification. Animals, as a rule, bear their young easily. When any disproportion exists between the fœtal head and the maternal pelvis both mother and offspring perish and the peculiarity is not transmitted. Savage women are under much the same conditions, and give birth almost as easily as lower animals. But for ages civilized women in labor have received artificial aid; they are, therefore, nearly all incapacitated for a time after the birth of each child; indeed, the recent advance of obstetric science has enabled so many of the otherwise unfit to survive among us for some generations past that now numerous women are quite unable of parturition without instrumental aid.*

The evolution of the power of acquiring characters, mental and physical, appears to me the most important, indeed the very central fact in the evolution of all the higher animals. Beyond all other characters this has been steadily evolved by Natural Selection, and therefore the higher placed an animal is in the scale of life the more is it developed in him. Possibly some other mammals are as capable of acquiring physical characters as man; it may be that as much of the physical development they undergo after birth is due to the effects of use and exercise; but, beyond question, no other animal is mentally so receptive as man. His power of acquiring mental characters (*i. e.*, his memory) is enormous, and so greatly does he depend on it for survival that, as we have seen, his inborn mental characters (*i. e.*, his instincts), except in a few instances, have undergone complete retrogression. His mind, as I have said, is a blank at birth, and it follows, since so much is acquired, that the disposition or character of every man must be almost entirely acquired, and not inborn, as is usually assumed. Part of the contents of his memory are recognizable (*i. e.*, may be distinctly remembered), but very much, especially all that is acquired during infancy, is not so. We speak of it as 'forgotten,' but forgotten things, though they can no longer be represented in consciousness, yet leave their impress on the mind. To take an illustration: imagine twin infants in the same cot, one awake and the other asleep; suppose an event happens that alarms the waking child, but leaves the other unaffected; suppose, again, that subsequently another event, observed by both children, occurs, which, owing to the apprehension and nervous irritability engendered by the previous event, again alarms the first child, and thus increases its irritability, but, because of its previously undisturbed equanimity, again leaves the second unaffected by fear; imagine this process repeated; then, though the original cause of fear were quite forgotten, the one child might well grow up of a much more timid and

*The use of forceps was formerly very rare in midwifery practice, but is now very common. Doubtless this is mainly due to a change in fashion, the modern obstetrician, on the average, being more skilful and, therefore, more ready to use his instruments than his forebear; but, doubtless, also, it is due in part to a growing disproportion between the maternal pelvis and the fœtal head in highly civilized races. It is not possible that the saving of so many narrow-hipped women and big-headed children can have left the race unaffected.

nervous disposition than the other; in which case every one would speak of the former as *naturally* (*i. e.*, innately, instinctively) more timid than his brother, though, in fact, his excess of timidity would be acquired.

In practice, owing to the necessity of the case, we act as if we realized that man's mind, his character, his disposition, is almost entirely acquired; and, therefore, every parent carefully trains his child for a prolonged period, striving by precept and example to inculcate fit mental traits, that is, fit knowledge and ways of thinking and acting. Even the savage mother does this, and civilized nations have vast state establishments for educating their youth. Moreover, we realize that a child reared by the brave or the cowardly, the active or slothful, the moral or the immoral, the patriotic or the non-patriotic, the devout or the sceptical, and so forth, will exhibit the traits of his educators, even if they be not his progenitors. In fact, we realize, as regards man (though this is not true as regards such animals as the dragon-fly, in which, as we have seen, the mentally acquired is practically non-existent), that the mind of one generation imprints itself on the mind of the next, not racially, but educationally; but, in thinking of this or that adult man, or this or that race of men, we are apt to consider their mental peculiarities as innate and acquired. Especially is this done by men of learning, historians, anthropologists, psychologists, philosophers and the like. It is not realized by them that *man's real mental evolution has lain in the evolution of his power of acquiring mental traits*, and that not in a single other inborn peculiarity does he mentally transcend lower animals, and, therefore, that one adult individual or race must differ from another individual or race wholly in the traits that are acquired, *and in the power of acquiring them*. For example, no man or race is born with greater musical, artistic or mathematical powers than any other man or race, but merely with greater powers of acquiring them; for, in the absence of appropriate stimulation (*i. e.*, experience, education), they do not develop even in the most 'gifted.' It seems probable, moreover, that powers of acquiring these and other particular faculties have not been separately and especially evolved by Natural Selection, but, on the contrary, that they are but particular manifestations of the general power of acquiring mental traits, which is what has been evolved by Natural Selection.* Thus there appears to be no more reason for supposing that the mathematical faculty has been especially evolved than for supposing that the faculty for understanding the uses of machinery has been evolved; both the one and the other must have been equally useless to the primitive savage.

In lower animals the amount of mental receptivity is closely associated with the size of the brain, the larger brain being the concomitant of greater receptivity, and, as a consequence, of lessened instinct. Associated with this truth is the fact that modern representatives of ancient animals (*e. g.*, ungulates) have much larger brains than their ancestors, denoting the evolution in them of the supremely important faculty of acquiring mental characters. Now, since so little that is mental is inborn in man while so much is acquired, we must conclude that differences in the sizes and shapes of the brains of different races imply not inborn mental differences, but differences in the power of acquiring mental characters, and, therefore, for example, that the native Australian, with his small

* Of course, I do not mean by this that the man who is capable, for instance, of high musical attainments, is also necessarily capable of high mathematical attainments. We know that this is not so. Nevertheless, even as regards these faculties much must depend on the 'bent' given to the individual's mind by circumstances occurring early in life.

brain, differs from the Chinaman or Japanese, with his large brain, not mainly in that which is mentally inborn, but mainly in that he has lesser power of acquiring complex mental characters. If this is true, and there is a mass of evidence proving that it is true, for children of one race reared by another and very different race develop the mental features of their educators, not of their progenitors (*e. g.*, Europeans reared by savages or savages reared by Europeans),* then much of the reasoning of numerous thinkers has been founded on false premises, and is invalid. They have commonly estimated the mental calibre of a race by the intellectual feats performed by it, but plainly these are wrong criteria, since whether these feats be great or small depends almost entirely on the environment, that is, on education. A South Sea Islander, for instance, would, and could, do nothing in his ancestral environment compared to what he would be intellectually capable of were he during early life transferred and trained in the midst of a learned and scientific society.

In discussing this subject one is embarrassed by the wealth of the material that presents itself for criticism. In the lightest, as in the weightiest literature, it is constantly assumed that various racial peculiarities and differences which are manifestly acquired are inborn—that this or that race is inherently brave or resolute, or enterprising, or industrious, or gifted with a genius for colonization or empire, while this or that other race is timid, or irresolute, or indolent, or servile, and so forth. To illustrate my remarks and conclude my essay I may cull a few examples from an enormous field. Dr. Francis Galton says: "The importance to be attached to race is a question that deserves a far larger measure of exact investigation than it receives. We are exceedingly ignorant of the respective ranges of the natural and acquired faculties in different races; and there is too great a tendency among writers to dogmatize wildly about them, some grossly magnifying, others as greatly minimizing their several provinces. It seems, however, possible to answer this question unambiguously, difficult as it is."* But, if I am right, as I think I am, in the foregoing, surely *every* writer has too greatly exalted the importance of the inborn and too much minimized the importance of the acquired factor in man. Does not Dr. Galton himself exalt vastly too much the importance of the inborn factor, as witness the following passage, which, in this respect, is similar to many others in his work:

"The long period of the Dark Ages, under which Europe has lain, is due, I believe, in a very considerable degree, to the celibacy enjoined by religious orders on their votaries. Whenever a man or woman was possessed of a gentle nature that fitted him or her to deeds of charity, to meditation, to literature or to art, the social condition of the time was such that they had no refuge elsewhere than in the bosom of the Church. But the Church chose to preach and exact celibacy. The consequence was that these gentle natures had no continuance, and thus, by a policy so singularly unwise and suicidal that I am hardly able to speak of it without impatience, the Church brutalized the breed of our forefathers. She acted precisely as if she had aimed at selecting the rudest portion of the community to be, alone, the parents of future generations. She practiced the arts which breeders would use, who aimed at creating ferocious, currish and stupid natures. No wonder that club law prevailed for centuries over Europe; the wonder rather is that enough

* Consider, for instance, how different in either case would be the contents of memory and all that arises out of memory.

* 'Hereditary Genius,' preface to edition of 1892, p. xxv.

good remained in the veins of Europeans to enable their race to rise to its present, very moderate, level of natural morality." * Dr. Galton implies that a tendency to charity, meditation or to the cultivation of literature is an inborn and transmissible character, whereas they are, in fact, acquired. A Quaker's child, for example, reared by North American or West African savages shows none of the gentle altruistic nature of his progenitors, and obviously shows no literary tendencies. The child of a bloodthirsty and immoral savage may be made sanctimonious to an even unpleasant degree, as has happened under the influence of missionaries in certain Polynesian islands, where by act of the native legislature flirtation is now a legal offence. The children of aborigines have done exceedingly well, as compared to Europeans, in the Australian government schools. The Church, therefore, may have brutalized society in the Dark Ages, by its influence on the characters acquired by the individuals comprising it; for instance, by inculcating celibacy it may have prevented people who had acquired the best characters from having families, and so passing on their acquired excellencies, like language or even property, to descendants. But since mere chance, not innate tendencies, must have determined in each case the inclination or disinclination towards charity, etc., the Church cannot have selectod any *particular type*, and therefore cannot have caused real evolution or retrogression.

It is, of course, impossible for obvious reasons to prove of a particular person with (for instance) charitable inclinations that in a different environment he would have acquired different inclinations. But what cannot be proved of the individual can be proved of the race, which is but an aggregate of individuals. If my definitions are correct, innate inclinations or tendencies are of the nature of instincts, and these can arise only very slowly under the prolonged action of Natural Selection, and, if they disappear, can do so only equally slowly after cessation of selection. But consider how rapidly a race (*e. g.*, the Japanese) may change its characteristics. Consider, in particular, the enormous change, as expressed in the resultant civilization, which occurs in the character of a race when it changes its religion. Compare the mental characters of the races of Asia Minor and North Africa as they changed successively from Pagan to Christian and from Christian to Mohammedan. Consider how much Pagan, Mohammedan and Christian negroes differ in their mental characters. Consider how closely Mohammedans of all races resemble one another mentally. Consider how indistinguishable mentally are Catholic Teutons from Catholic Celts in Ireland, and how markedly they differ both from the Protestant Teutons and the Protestant Celts of Great Britain. I have, however, dealt somewhat fully with this matter of religion elsewhere,* and my space here is limited. Still I am in hopes that the little I have said proves that any tendency towards charity, etc., is wholly acquired and not inborn.

Again Galton says: "The ablest race of which history bears record is unquestionably the ancient Greek, partly because their masterpieces in the principal departments of intellectual activity are still unsurpassed, and in many respects unequalled, and partly because the population that gave birth to the creators of those masterpieces was very small. Of the various Greek sub-races, that of Attica was the ablest."† He further says: "The average ability of the Athenian race is, on the lowest possible estimate, nearly two grades higher than our own—that is, about as

*Ibid, p. 343, 344.

*'The Present Evolution of Man,' p. 188-196.

†'Hereditary Genius,' p. 329.

much as our race is above that of the African Negro. This estimate, which may seem prodigous to some, is confirmed by the quick intelligence and high culture of the Athenian commonalty, before whom literary works were recited and works of art exhibited, of a far more severe character than could possibly be appreciated by the average of our race, the calibre of whose intellect is easily gauged by a glance at the contents of a railway book-stall."* De Quatrefage says: "There can be no real relation between the dimensions of the cranial capacity and social development." * * * "By such an extension the Troglodytes of the Cavern of L'Homme-Mort would be superior to all the races enumerated in the table, including contemporary Parisians."† But Mill wrote: "Of all vulgar modes of escaping from the consideration of the effect of social and moral influences on the mind, the most vulgar is that of attributing the diversities of conduct and character to inherent natural differences;"‡ and Buckle, the historian, who, notwithstanding the deficient knowledge of his time, had a true appreciation of the problem, said: "Whatever, therefore, the moral and intellectual progress of men may be, it resolves itself, not into a progress of natural capacity, but into a progress, if I may say so, of opportunity, that is, an improvement in the circumstances under which that capacity after birth comes into play. Here, then, lies the gist of the whole matter. The progress is one not of internal power, but of external advantage. The child born in a civilized land is not likely as such to be superior to one born among barbarians, and the difference which ensues between the acts of the two children will be caused, so far as we know, solely by the pressure of external circumstances, by which I mean the surrounding opinions, knowledge, associations, in a word, the entire mental atmosphere in which the two children are respectively nurtured."*

Mill and Buckle, though unacquainted with the doctrine of evolution, were surely right. The ancient Greeks and Romans were certainly of extraordinary mental prowess, but it is more than probable that they surpassed our more remote ancestors only because the environment in which they lived was more favorable than the mediæval to the acquirement of fit mental traits; because, in their free, intellectual atmosphere, they were trained to the performance of intellectual feats, which were impossible to the fettered minds of our forefathers, who could hardly achieve greatness, except as priests or warriors, or as painters, sculptors, architects, musicians, or as other laborers in such arts as served the grandeur of the Church or the Throne. The splendor of the Greek and Roman achievements, therefore, does not constitute a proof that the Greeks and Romans were splendidly endowed, but only that the traits which they acquired from their progenitors enabled them to use their endowments splendidly. In judging of the mental capabilities of a people as a whole, as in judging of physical powers, it is safer to take as a test their corporal structures, their bodies and brains, rather than their physical and mental feats, for whether these latter be great or little depends on circumstances which may be favorable or the reverse. Had the Troglodytes received the same mental training as the Greeks it is possible or probable, since their brains were large, that they would have performed feats intellectually as great, but had Aristotle or Plato received the training of the cave-men great feats would have been impossible to them. They would have died

* Ibid, p. 330–331.

† 'The Human Species.'

‡ Mill's Principles of Political Economy, Vol. I., p. 390.

* Buckle's History of Civilization, Vol. I., p. 178.

unknown to fame. Moreover, such feats as were performed by the Greeks would not have been recognized as great among prehistoric peoples, and such intellectual giants, but physical weaklings, of the modern world as Darwin and Spencer would have earned, and in that state of society deserved, the contempt of their fellows.

Mr. Herbert Spencer attributes much of the contents of man's mind to the transmission and accumulation of acquired mental characters. Thus he attributes the altruistic feelings to this cause and anticipates a happy future for many by their continued increase. Mr. B. Kidd, whom I confess I have a little difficulty in taking seriously, on the other hand, attributes these feelings to Natural Selection. He is very severe on Mr. Herbert Spencer and writes: "The confusion of ideas to which the tendencies of the times give rise finds remarkable expression in Mr. Herbert Spencer's writings."* The tendencies of the time seem to have confused Mr. Kidd's own ideas to an even greater extent, and it would have been well had he harkened to Mr. Spencer's warning against thinking in abstract terms.†

As already indicated in this JOURNAL,‡ Natural Selection implies elimination of the unfittest, and Mr. Kidd has failed to record a single death as due to the absence of this feeling in him who perished, and the presence of it in him who survived. Having regard to the foregoing, is it not abundantly evident that the altruistic feelings have not undergone evolution at all in man, neither by the transmission of inborn characters nor that of acquired characters? As I say the child of a philanthropist if reared by West African savages might well be a fiend in cruelty, he certainly would have no philanthropic tendencies as we understand them; the child of a cannibal, properly trained, might well develop into a philanthropist; and surely that which may be entirely lapsed or developed in a single generation cannot properly be regarded as a direct product of evolution. Like patriotism, or devotion to a particular religious system, or a knowledge of language, or of letters, or of the uses of steam, or of the bicycle, the altruistic feelings are purely acquired (and not transmissible), and are not immediate products of evolution, but result indirectly from the evolution of man's mental receptivity, that is, from the evolution of his vast power of acquiring mental characters. Men in various times and places have been *taught* to worship sticks and stones, and to hold in reverence all kinds of absurd beliefs and notions, so also a child—any child—by fit training may be rendered highly altruistic—may be taught to receive and practice altruism, as he may be taught to reverence and practice fetishism; whence it follows, as a logical conclusion, that in every individual the altruistic feelings are purely acquired. It matters not that, in a greater or less degree, they are universal. So is knowledge of language and religion, which, though universal, is as much acquired as is a knowledge of history or of astronomy. If, then, in the ancestry of man, these feelings were ever instinctive, as we may suppose them to be among bees, this instinct, like almost all others, was lapsed long ago, and was replaced by an acquired character.* We need not await, then, the slow evolution of the social millenium by the accumulation of inborn altruistic variations, as Mr. Kidd expects, nor by the accumulation (and transmission) of acquired variations, as Mr. Spencer expects. Were we all agreed

* 'Social Evolution,' p. 158.

† 'The Inadequacy of Natural Selection,' p. 67.

‡ September 11, 1897, p. 371.

*I cannot here pause to discuss the cause of the retrogression of instinct. But I have dealt at length with the cause of the retrogression of physical parts in my book, and that of the retrogression of instinct follows the same law. An outline of the theory was given in SCIENCE of September 3, 1896.

as to the training of our children it would be achievable in the very next generation, for surely, if a generation can be reared to reverence a stick or a stone, an inanimate idol, and this or that grotesque religious system, it can be reared also to love and reverence man.

One paragraph more and I have done. We hear of the evolution of morals or of language or of religion, of the printing press, of the locomotive, of the bicycle, and so forth. In the popular mind, and, I fear, even in the minds of some scientific men, this evolution ranks as a process of the same order as the evolution of a plant or animal. Evolution means unfolding, and, therefore, the word is perhaps correctly applied to the bicycle, etc. But there is this essential difference between a living being and the bicycle: The former is the progeny of a parent; the latter is not. So also the language of to-day is in a figurative sense only the progeny of the language of the former times; the morals of to-day have, in a figurative sense only, descended from those of yesterday. All these things are human inventions, and belong not to human evolution, but to what has been called evolution in the environment. The so-called 'Social Evolution,' of which we have lately heard so much, is therefore a myth from the biological standpoint. As I have said, and as I wish to iterate and reiterate, neither the altruistic feelings in particular, nor morals in general, nor anything of the kind, has undergone evolution in man. What has undergone evolution is his enormous power of acquiring characters, these among others. G. Archdall Reid.

Southsea, England.

SOME RECENT OBSERVATIONS ON THE INFLUENCE OF THE THYROID GLAND ON METABOLISM.

In an article by Professor Chittenden, published in Science, June 25th, a summary is given of what was then known regarding the influence of the thyroid gland on metabolism. Since that time a valuable contribution to our knowledge has come from Bernhard Schöndorff, published in Pflüger's Archiv für Physiologie (Band 67, p. 395). He finds that, contrary to previously received notions, the feeding of thyroid glands or iodothyrin to an animal does not invariably stimulate proteid metabolism. Further he finds that the loss of weight so often observed under such treatment is due mainly to an increased combustion of the body-fats, and that the increased excretion of nitrogen through the urine observed by Voit and others is not necessarily due to an increased proteid metabolism, but to an increase in the excretion of urea and allied bodies which are known to exist pre-formed in the tissues in considerable quantities.

The investigation was carried out on a dog of 55 pounds weight. It was kept in a suitable cage, and its food so regulated that under ordinary conditions the animal remained at a constant weight and in nitrogenous equilibrium. The thyroids were administered for the most part in the form of dry tablets prepared by Borroughs, Wellcome & Co., of London, but sometimes fresh or dried sheep's thyroids were given either alone or with the tablets. At first the dosage was ten of these tablets administered with the daily food. Within a few hours the animal's weight began to fall, and at the end of twenty-three days it had lost nearly two and a half pounds. During the first eight days the nitrogen also showed a minus balance; that given off in the urine and feces amounted to 32 grams, while the food contained only 31 grams. During the next fifteen days, however, there was a plus balance. Evidently these results point to a largely increased consumption and elimination of non-nitrogenous material, and in the light of previous researches Schöndorff attributes them to an increased combustion

of the fats. But they throw very little light upon the proteid metabolism.

For the succeeding twenty-four days the dosage was raised to twenty tablets a day. The effect was unmistakable. The nitrogen eliminated was 4% in excess of that contained in the food. The loss of weight amounted to 2.25 kilos, or nearly five pounds, and at the close of the period the animal was so thin that its ribs and pelvic bones showed plainly. When, however, the nitrogen loss (in all 30 grams) is multiplied by the figure 30, which Pflüger has shown to represent the ratio between the proteid tissues and their nitrogen content, it is evident that the albuminous waste can account for only three-sevenths of the total loss of weight. The other four-sevenths (in all three pounds) must have come from the fats, which implies an increase of combustion to the extent of 43%. The violent panting of the animal points to the same conclusion; while the loss of nitrogen shows that, just as is the case during prolonged hunger, when the supply of fat has been reduced to a certain limit, the system falls back upon its proteids to meet the demands caused by iodothyrin.

At this point the administration of thyroid tablets was stopped, and contrary to the statements of some observers, that iodothyrin has a considerable after-effect, the nitrogen balance became positive immediately and the body weight increased rapidly.

When the animal had again attained its normal weight, the investigation was repeated. Twenty tablets a day were administered. The animal's weight fell a pound a week. For the first few days the nitrogen in the excreta exceeded that in the food by 8%. But the daily analyses showed that by the twelfth day nitrogen demand and supply were again in equilibrium.

At the end of two months, however, the weight ceased to fall. The tablets were discontinued for a week, and the weight rose one and a half pounds. On administering the tablets again for two weeks the weight fell one and a half pounds, but the nitrogen maintained a steady plus balance.

From these facts Schöndorff concludes that in the case of an animal at a uniform weight and in nitrogenous equilibrium iodothyrin causes an increase of combustion and a consequent loss of weight. So long as the store of fat is above a certain limit proteid metabolism, however, remains unaffected; the temporary minus balance of the body's nitrogen is due to an increased elimination of urea and similar substances which existed pre-formed in the tissues; but when the fats have been reduced below a certain limit the proteids are likewise attacked. Throughout his investigations, however, Schöndorff assigns all the effects produced to the iodothyrin contained in the ingested thyroids. He accepts the prevailing opinion of physiologists, that the iodothyrin isolated by Baumann is the full physiological equivalent of the gland, and at no time during the research was the pure substance administered in place of the glands. Yet experiments by Dr. Edm. Wormser, published in a later number of Pflüger's Archiv (Band 67, p. 505), seem to show that the thyroid itself or an aqueous extract of the gland possesses a physiological activity (at least when fed to animals whose thyroids have been removed) far in excess of that exhibited by pure iodothyrin. Similar results have been obtained by A. Schiff, who has been working at this question simultaneously, though quite independently. (Wiener Klin. Wochenschr. 1897, p. 277.) Schiff, however, states that different preparations of iodothyrin vary considerably in the extent of influence they exert, but he asserts that no preparation shows a physiological activity at all comparable to that of the gland itself. If later researches verify these observations they

will prove that, as Wormser claims, iodothyrin is not the only active body secreted by the thyroid, but that some other substance must act with it in order to perform all the functions of the gland.

Wormser's experiments were carried out upon dogs whose thyroids had been carefully removed. The animals were fed with various preparations made from thyroids as well as such artificial compounds as sodium iodide and iodo-casein, and the influence of these substances, in preventing or lessening the tetanus and other symptoms resulting from the operation, was noted.

The first animal experimented upon was fed with dry thyroids for twenty days after the thyroidectomy, and during this time its condition showed nothing abnormal. On the twenty-first day the dry thyroids were replaced by iodothyrin in such quantity that the iodine content equaled that of the previously administered glands. Two days later the animal was seized by a violent tetanus. The dry thyroids were again administered, and the dog recovered in a few hours. The glands were again replaced by iodothyrin, and the animal died within thirty-six hours. This experiment was repeated three times with iodothyrin prepared from sheep and pigs by both of Baumann's methods, and the results agreed perfectly.

Iodo-casein, an artificial compound, has been found efficacious in reducing the size of a goitre. When this substance was administered to dogs whose thyroids had been removed, the intensity of the tetanus seemed to be reduced, but death nevertheless ensued. Similar experiments were tried with sodium iodide, and with the albuminous material precipitated from a sodium chloride extract of the thyroid gland by acetic acid. These results, however, were entirely negative.

Wormser notes, however, that throughout these investigations he found young animals far more susceptible to the evil effects of thyroidectomy than fully mature or old animals, while the appearance of tetanus and other symptoms was delayed by a milk diet, but hastened by one largely composed of meat.

Finally, in summing up the results of his experiments, Wormser points out that the thyroid itself or an aqueous extract of the gland is far more potent physiologically than any substance yet isolated from the gland or artificially prepared, and that therefore no one substance can account for all the functions of the thyroid.

YANDELL HENDERSON.

THE ENZYMIC FERMENTS IN PLANT PHYSIOLOGY.

FERMENTATION, as a general term, covers many of the most important processes in chemistry. Fermentations are of many particular kinds, each depending more or less distinctly upon some specific ferment agent. This makes it convenient to classify the fermentation processes according to the correlated ferment agents. Thus we have yeast fermentation, bacterial fermentation, enzymic fermentation and the like.

The ferment agents, and, following them, the fermentation processes, may be roughly thrown into three classes: (1) Those belonging to the lower orders of fungi, like yeast. (2) Bacteria, like those present in the 'mother' of vinegar, or in the souring of milk. These two classes are often called organic ferments in distinction from the next. (3) Unorganized, or soluble ferments, or enzyms, like diastase, pepsin and ptyalin. The knowledge of these enzyms is mostly of very recent development, and is still fragmentary and generally unsatisfying. They have been best known as they occur in the animal digestive juices. The students of animal physiology have been used for some years to point out the presence of ptyalin and diastase in saliva, of pepsin and trypsin in the gastric juice, and

of pancreatin, trypsin and diastase in the pancreatic secretions. And in a very hazy sort of way it has been known for a considerable time that the same and similar ferments are active in the physiological processes of plants. In very recent years the sharp press of experiment upon all phases of plant economy has brought to light many facts of almost startling interest. We may reasonably hope to collect observations enough within a few years to make generalization practicable; but up to the present we are doing fairly well to get some detached notions of certain of these enzyms, of their nature and action, and their relation to important vegetation processes.

The certain determination, even qualitatively, of all the enzyms present in any given part of a plant can hardly be safely made in any case; but it is known that various enzyms are present in nearly all the living organs. Each plant—especially among the flowering plants—takes up quantities of food materials, which it circulates, digests, stores, unstores, circulates again, assimilates, breaks down and finally, perhaps, excretes. In all the multifarious processes of digestion and redigestion the enzyms may take prominent part. They are almost always found in connection with special food storages, as in buds, tubers, bulbs and seeds.

Before a healthy deciduous woody plant enters upon its period of rest it stores up a considerable quantity of food with which to begin work again in the spring. These storages are largely of starch, and may be demonstrated by the iodine stain under a lens in the woody tissues of stems, especially near buds, or in the roots. The regions of fruit buds in such plants as apple and plum commonly show remarkable storages of this sort. With returning spring, before the roots start or before the leaves are put out to capture and digest food, these stores of starch and other materials are put in motion once more, and from them the new leaves are built or the early blossoms pushed forth. Theoretically and from experiment we are led to believe that these early redigestive processes are dependent on certain enzymic ferments.

In a quite similar manner those plants which propagate their species by means of tubers or bulbs store quantities of food in such organs which later can be reabsorbed and used to start the young plantlet. The recent remarkable results reported by Johanssen before the Agricultural High School of Copenhagen, and so liberally noticed in the public prints of America, were brought about by the application of ether fumes to secure an early liberation of these stores of food in bulbs and dormant woody plants.

Seeds act in the same way. When perfectly ripe and viable seeds are brought into conditions favorable to germination, the relatively large stores of food which they contain are released for the use of the nascent plant. In this case the activity of diastasic ferments is comparatively well known. Perhaps other enzyms are also present and active. The chief commercial source of diastase, in fact, is malt, that is, grain taken at the height of the germination activities. It has been often observed that seeds do not germinate well if planted immediately after ripening; that a period of rest increases the promptness and vigor of germination; and it has been thought probable that this period of rest is useful in allowing the accumulation of the necessary enzymic ferments.

One of the facts of commonest knowledge is that seeds deteriorate in viability when kept for some time. The period at which all the seeds of a sample lose their power of germination varies from two to twenty years or more, but most garden seeds deteriorate rapidly after they are three years of age. It has seemed probable that this

reduction in viability is due to the diminution in quantity or loss in quality of the enzyms in the seeds. Some very interesting experiments made in the experiment station of the University of Vermont tend to establish this theory, as well as to offer some applications of practical value. Various old seeds were treated with different enzym solutions and were then placed in suitable apparatus for germination. One lot of tomato seeds, twelve years old, soaked for twenty-four hours before germination, gave the following results:

Soaked in water	28	per cent germinated.
Soaked in trypsin	56	" "
Soaked in Extractum pancreatis	36	" "
Soaked in Enzymol	52	" "

Another lot of seeds of another variety of tomato, twelve years old, gave these results:

Soaked in water	34	per cent. germinated.
Soaked in diastase	70	" "

One of the most remarkable experiments was with another lot of tomato seeds, also twelve years old. The result stood:

Soaked in water	12	per cent. germinated.
Soaked in pepsin	80	" "
Soaked in diastase	85	" "

This shows an increase of 567 per cent. and 608 per cent. respectively in the germination through the action of the enzyms artificially supplied. Other seeds of other species and other enzymic preparations gave similar results.

In view of our present knowledge it seems quite fair to hope that, when we understand better the enzyms and their relation to the processes of vegetable physiology, we shall be able to control to our advantage many of the critical steps in plant development.

FRANK ALBERT WAUGH.

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CURRENT NOTES ON ANTHROPOLOGY.

THE OLDEST CRANIA FROM CENTRAL MEXICO.

IN his work, 'Anthropologie du Mexique,' published in 1884, Professor Hamy gave the measurements of a number of skulls obtained from sepultures of uncommon depths in various parts of central Mexico. Those at Tlaltelolco were from seven to eight feet below the surface and appeared to date from a remote antiquity. These skulls were all characterized by marked brachycephaly, with indices of 85 and upward.

In the *Bulletin du Museum d' Histoire Naturelle*, 1897, No. 6, the same author reports the measurements of five skulls from very ancient burial sites in the district of Colotlan, State of Jalisco. The cranial capacity is good (male 1485, female 1280), but all five of them were remarkably brachycephalic, the average being above 86, and the highest reaching 92.40!

The modern graves, on the other hand, yield skulls which are distinctly dolichocephalic, and the present native population is of this character. They are the Guicholas, speaking a dialect of Nahuatl. They assert that these older graves are not those of their ancestors, but of another race; and the difference in the art-remains substantiates this tradition. Professor Hamy concludes that all the oldest tribes of central Mexico were broad-skulled, with marked alveolar prognathism.

THE OLD LAND-BRIDGE TO EUROPE.

IN the introduction to my 'American Race' I pointed out the arguments for the existence of a land-bridge from North America to Europe in pleistocene times, across which the ancestors of the American man might have journeyed. Since the publication of that work a number of writers have advocated this hypothesis, as Georges Hervé, Charles Tissot, M. Lapparent, etc. The latest is M. Philippe Salmon, ex-President of the Anthropological Society of Paris.

In a paper in the *Revue Mensuelle* of the Paris School of Anthropology, for September, he undertakes to locate the period of the final disruption of the two continents more accurately than heretofore.

He carefully considers the pleistocene fauna of both areas, compares the states of the earliest arts, and especially lays stress on the time and manner of the disappearance of the reindeer in France, and the sudden change of climate from arctic to temperate conditions which that indicates. The cause of this change was the altered direction of the current of the Gulf Stream owing to subsidence of the land areas. His article entitled 'L'Atlantide et le Renne' will be found highly suggestive.

D. G. BRINTON.

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SCIENTIFIC NOTES AND NEWS.

AMERICAN MATHEMATICAL SOCIETY.

THE annual meeting of the American Mathematical Society will be held on Wednesday, December 29th, in Room 301 of the Physics Building of Columbia University, New York City. In accordance with the provisions of the constitution of the Society, the annual election of officers will be held at this meeting, and a presidential address, 'On the Philosophy of Hyperspace,' will be delivered by President Simon Newcomb. The sessions will begin at 10:30 a. m. and 2:30 p. m., and the Council will meet at 2 p. m.

The following is a list of papers thus far entered for presentation at the meeting:

Morning Session.

(1) 'On the differential equations defining the Laplacian distribution of density, pressure and acceleration of gravity in the earth,' PROFESSOR R. S. WOODWARD, Columbia University; (2) 'The theorems of oscillation of Sturm and Klein,' PROFESSOR MAXIME BÔCHER, Harvard University; (3) 'On some points in the theory of functions,' PROFESSOR A. S. CHESSIN, Johns Hopkins University; (4) 'Point transformation in elliptic coördinates of circles having double contact with a conic,' DR. EDGAR ODELL LOVETT, Princeton University,' (5) 'Certain invariants of a plane quadrangle by projective transformation,' DR. EDGAR ODELL LOVETT, Princeton University.

Afternoon Session.

(6) Presidential address: 'The philosophy of hyperspace,' President SIMON NEWCOMB, Washington, D. C.; (7) 'Limits of transitivity of substitution groups,' DR. G. A. MILLER, Chicago, Ill.; (8) Some theorems in n-dimensional space,' MR. C. J. KEYSER, Columbia University; (9) 'The orthogonal group in a Galois field,' DR. L. E. DICKSON, University of California.

The Chicago Section of the Society will hold its second meeting on Thursday and Friday, December 30th and 31st, at Northwestern University, Evanston, Ill. Regular meetings of the Society will be held in New York on February 26th and April 30, 1898. The summer meeting will be held next year at Boston, Mass., in connection with the meeting of the American Association for the Advancement of Science.

The membership of the Society now exceeds 300. The November number of the *Bulletin* (Vol. VII., No. 2) contains, besides the 'Notes' and 'List of New Publications,' an account of the International Congress of Mathematicians held at Zürich last August; a report by the Secretary, Professor James McMahon, of the proceedings of Section A at the Detroit meeting of the American Association for the Advancement of Science; 'Quaternions as Numbers of Four Dimensional Space,' by Professor Arthur S. Hathaway; 'Note on the Invariants of n Points,' by Dr. Edgar Odell Lovett; 'Note on the Fundamental Theorem of Lie's Theory of Continuous Groups,' by Dr. Edgar Odell Lovett; 'A Geometrical Locus Connected with a System of Coaxial Circles,' by Professor Thomas F. Holgate; 'Condition that the Line Common to $N-1$ Planes in an N Space may Pierce a Given Quadric Surface in the Same Space,' by Dr. Virgil Snyder, and a review of Lamb's *Hydrodynamics* by Professor Ernest W. Brown.

The December number of the *Bulletin* (Vol. VII., No. 3), which has just appeared, contains an account of the October meeting of the Society, by the Secretary; 'Note on Hyperel-

liptic Integrals,' by Professor A. S. Chessin; 'Certain Classes of Point Transformations in the Plane,' by Dr. Edgar Odell Lovett; 'Continuous Groups of Circular Transformations,' by Professor H. B. Newson; a review of Plücker's *Collected Papers*, by Professor Charlotte Angas Scott, and 'Notes' and 'New Publications.'

THE AMERICAN SOCIETY OF NATURALISTS AND AFFILIATED SCIENTIFIC SOCIETIES.

THERE is every indication that there will be an unusually full attendance at the Ithaca meeting beginning on Tuesday of next week. The following is a list, revised to December 21st, of those who have already signified their intention of being present.

New York City and Columbia University: Dr. H. F. Osborn, Dr. E. B. Wilson, Dr. G. S. Huntington, Dr. F. S. Lee, Dr. J. McK. Cattell, Dr. S. J. Meltzer, Dr. L. Farrand, Dr. J. A. Blake, Dr. R. Hunt, Mr. N. R. Harrington, Mr. H. E. Crampton, Jr., Dr. Franz Boas, Mr. C. A. Strong, Mr. S. I. Franz, Professor L. M. Underwood, Mr. Lloyd, Dr. C. L. Bristol, Brother Chrysostom.

Harvard University: Dr. G. H. Parker, Dr. G. W. Fitz, Dr. H. M. Richards, Dr. C. B. Davenport, Dr. C. R. Eastman, Miss Ida H. Hyde, Dr. H. P. Bowditch, Professor Chas. S. Minot, Professor W. T. Porter, Professor Josiah Royce.

Philadelphia and University of Pennsylvania: Dr. E. G. Conklin, Dr. J. M. Macfarlane, Dr. John W. Harshberger, Dr. Adeline F. Schively, Dr. Martha Bunting, Dr. Hobart C. Porter, Miss Caroline Thompson, Dr. A. P. Brubaker, Professor G. S. Fullerton.

New Haven and Yale University: Professor W. H. Brewer, Professor R. H. Chittenden, Dr. W. C. Sturgis, Professor L. B. Mendel, Professor Graham Lusk, Professor Herbert E. Smith, Dr. A. W. Evans, Dr. H. B. Ferris.

Baltimore and Johns Hopkins University: Dr. E. A. Andrews, Dr. Ross Granville Harrison, Dr. F. P. Mall, Mr. Charles W. Green, Dr. W. H. Howell, Dr. M. M. Metcalf, Mrs. Christine L. Franklin, Professor E. H. Griffin, Mr. G. Lefevre.

Brown University: Dr. A. D. Mead, Mr. F. P. Gorham, Miss A. G. Wing, Dr. W. G. Everett, Dr. E. B. Delabarre, Dr. H. C. Bumpus.

Princeton University: Professor A. T. Ormond, Professor H. C. Warren, Professor J. G. Hibben, Professor J. Mark Baldwin, Dr. M. W. Urban, Professor William Libbey, Dr. W. M. Rankin.

Washington: Dr. Frank Baker, Professor D. S. Lamb, Dr. W J McGee, Dr. A. McDonald, Professor Chas. W. Stiles.

University of Chicago: Professor C. O. Whitman, Professor Jacques Loeb.

University of Michigan: Dr. J. P. McMurrich, Dr. F. R. Lillie, Dr. W. P. Lombard, Professor J. E. Reighard.

Smith College: Dr. H. H. Wilder, Dr. W. F. Ganong, Dr. W. C. Smith.

McGill University: Professor D. P. Penhallow, Professor E. W. McBride.

Wellesley College: Professor Clara E. Cummings, Dr. Grace C. Cooley.

Middlebury College and University of Vermont: Professor E. A. Burt, Professor D. Irons.

Williams College: Professor S. F. Clarke, Professor J. I. Peck.

Massachusetts Institute of Technology: Dr. R. P. Bigelow, Dr. Theodore Hough.

Syracuse University: Professor C. W. Hargitt, Dr. G. P. Clark.

Tokyo: Professor K. Mitsukuri.

Amherst College: Dr. G. E. Stone.

Rutgers College: Professor John B. Smith.

Clark University: Dr. C. F. Hodge.

Adelbert College: Dr. F. H. Herrick.

University of Wisconsin: Dr. Joseph Jastrow.

Northwestern University: Dr. William A. Locy.

Rhode Island College: Dr. Geo. W. Field.

Union College: Dr. Chas. S. Prosser.

Bryn Mawr College: Dr. T. H. Morgan.

University of Indiana: Professor C. H. Eigenmann.

Wesleyan University: Dr. C. H. Judd.

Allegheny College: Dr. E. L. Rice.

Dartmouth College: Dr. Wm. Patten.

Missouri Botanical Garden: Professor Wm. Trelease.

GENERAL.

IT has for some time been known that Senator Elkins, the 'boss' of the Republican party organization in West Virginia, has been urging the President to appoint as Fish Commissioner a person named Bowers, from Martinsburg, W. Va. The daily papers now contain the statement that this appointment has been definitely settled. The papers consequently charge the President with intending to break the law, which is explicit in regard to the qualifications for the office. We have recently expressed our opinion as to the value and reasonableness of the law, and have every reason to believe that the President would not wish to have it altered. That he should break the law is incredible.

IT is expected that the American Society of Naturalists and the affiliated scientific societies meeting at Ithaca will accept an invitation to

meet next year in New York. It is hoped that the Geological Society, at the approaching Montreal meeting, will also decide to hold its next winter meeting in New York.

THE ninth annual meeting of the American Folk-Lore Society will be held at the Johns Hopkins University, Baltimore, on December 28th and 29th.

THE chair in the section of chemistry of the Paris Academy of Sciences, vacant through the death of M. Schützenberger, has been filled by the election of M. Ditte, professor of chemistry at the Sorbonne.

DR. NANSEN will sail from New York on February 19th, and will return directly to Christiania.

PROFESSOR E. JADERAN has proposed to the Swedish Academy of Sciences that an expedition be sent next summer to Spitzbergen to make preparations for the measurement of a degree of latitude in the polar regions. It is then proposed that Russia should be invited to coöperate in the final measurement of a degree in 1899 and 1900.

WE learn from *Nature* that the French government, through its embassy in London, has presented to Sir Archibald Geikie a handsome vase of Sèvres porcelain in recognition of the services rendered by him to the Geological Survey of France.

ACCORDING to the recently published proceedings of the German Zoological Society it contains 205 members, of whom only one, Professor Leuckhart, of Leipzig, is an honorary member.

MR. V. H. BLACKMAN, Hutchinson Research Student of St. John's College, Cambridge University, and Mr. W. Morley Fletcher, Fellow of Trinity College, have gained the Walsingham Medals for biological research.

A COMMITTEE has drawn up a memorial to be presented to the New York Park Board, suggesting that the services of the late William A. Stiles be commemorated by giving his name to one of the newly projected parks in the city.

THE death is announced of Dr. Anthony Brownless, Chancellor of Melbourne University and founder of the medical school of the University, and a distinguished physician and man of science.

MR. JAMES BATEMAN, the botanist and horticulturist, died at Worthing, England, on November 27th, aged 86 years. He was one of the large group of Englishmen of wealth and leisure to whom science in Great Britain is so greatly indebted. In 1833 he sent the collector Colley to Demerara and Berbice to collect plants, and procured many orchids from Guatemala and elsewhere. In 1837 Mr. Bateman commenced the publication of his work on the 'Orchidaceæ of Mexico and Guatemala,' which he completed in 1843; this book, in atlas folio, comprised the most remarkable series of colored plates which had up to that time appeared, each of the plates costing over £200. His 'Monograph of Odontoglossum' appeared between 1864 and 1870.

DR. VON MARZ has presented to the Munich Academy of Sciences the original spectrometer of Fraunhofer, together with his prisms and his manuscripts. As an acknowledgment of this gift the Academy has conferred its gold medal on Dr. von Marz.

MR. ALFRED HARMSWORTH has loaned *The Windward*, the steamship used by the Jackson-Harmsworth expedition to Franz Josef Land, to Lieutenant Peary for his expedition next year.

A RESOLUTION has been introduced in the House of Representatives appropriating $20,000 for the representation of the United States at the International Fisheries Exposition to be held at Bergen, Norway, from May to September of next year.

THE bill passed by Congress prohibiting pelagic sealing by citizens of the United States contains a provision as follows: Section 9. That the importation into the United States, by any person whatsoever, of fur-seal skins taken in the waters mentioned in this act, whether raw, dressed, dyed or manufactured, is hereby prohibited, and all such articles imported after this act shall take effect shall not be permitted to be exported, but shall be seized and destroyed by the proper officers of the United States.

PROFESSOR S. B. BROWN, of West Virginia University, is preparing for the State Geological

Survey Commission a bibliographical and historical sketch of all the work that has been done for the study of geology, biology and the resources of West Virginia by public and private effort.

AT a meeting of the Board of Managers of the New York Zoological Society, on December 14th, it was announced by Professor Henry F. Osborn, Chairman of the Executive Committee, that subscriptions amounting to $65,000 had so far been received for the zoological gardens in Bronx Park. New subscriptions to the fund include $5,000 subscribed by J. Pierpont Morgan, $2,500 by Tiffany & Co., $2,500 by F. Augustus Schermerhorn, $2,500 by Philip Schuyler, $1,000 by George Crocker, $1,000 by Jacob H. Schiff, and $500 by Eugene G. Blackford. The Society now has 540 members.

A ZOOLOGICAL Society has been established in West Australia with a view of founding a zoological garden at South Perth.

MONEY has been appropriated by the trustees of Amherst College for the purchase of a new telescope to replace the old instrument in use at present, and the bequest of $18,000 for the purchase of a site for a new observatory will be expended as soon as the various plans for a new location have been carefully considered.

THE Iron and Steel Institute of Great Britain will hold its annual meeting at Stockholm in August of next year.

DR. ANNINGSON, Dr. Donald MacAlister and Professor Kanthack will represent Cambridge University at the Madrid International Congress of Hygiene and Demography in April, 1898.

AT the 284th regular meeting of the Biological Society of Washington, on Saturday, December 18th, officers for 1898 were elected, as follows: *President*, L. O. Howard; *Vice-Presidents*, B. E. Fernow, Richard Rathbun, F. V. Coville, Chas. D. Walcott; *Recording Secretary*, Charles Louis Pollard; *Corresponding Secretary*, F. A. Lucas; *Treasurer*, F. H. Knowlton; *Councillors*, W. H. Ashmead, C. W. Stiles, E. L. Greene, F. W. True, M. B. Waite.

AT the statutory annual meeting of the Royal Society of Edinburgh, held on November 22d, the following office-bearers were elected for the ensuing session: *President*, The Right Hon. Lord Kelvin, F.R.S.; *Vice-Presidents*, The Hon. Lord McLaren, F.R.S., the Rev. Professor Flint, Professor McKendrick, M.D., F.R.S., Professor Chrystal, Sir Arthur Mitchell, K.C.B., Sir William Turner, F.R.S.; *General Secretary*, Professor P. E. Tait; *Secretaries to Ordinary Meetings*, Professor Crum Brown, F.R.S.; Mr. John Murray, LL.D.; *Treasurer*, Mr. Philip R. D. Maclagan, F.F.A.; *Curator of Library and Museum*, Mr. Alexander Buchan, M.A., LL.D.

AN International Congress of Balneology will be held in Vienna in March, 1898. Further information regarding the Congress may be obtained from the General Secretary, Dr. Brock, of Berlin.

MR. WRAGGE, the meteorologist, who established and worked the first observatory on Ben Nevis, and who is now Meteorological Observer of Queensland, has arrived on the summit of Mount Kosciuszko, the highest mountain in Australia, for the purpose of establishing an observatory there.

THE bequest of the late Sir William McKinnon to the Royal Society for the purpose of furthering natural and physical science, including geology and astronomy, and for the furtherance of original research and investigation in pathology by prizes and scholarships, which we announced last week, will, it appears, amount to more than $80,000.

The Kansas University Quarterly for October contains two important articles by Professor Williston, one on the 'Range and Distribution of the Mosasaurs, with Remarks on Synonomy,' and the other on a Labyrinthodont from the Kansas Carboniferous. This, as Professor Williston remarks, is of particular interest, for while Professor Marsh had described the footprints of Labyrinthodonts from the Upper Carboniferous the tooth noted came from the Lower Carboniferous, or from an earlier horizon than noted elsewhere.

Appleton's Popular Scientific Monthly for January will contain a translation of the important address given by Professor His, of Leipzig, in memory of his friends Ludwig and Thiersch.

BEGINNING with January, 1898, the *American Geologist* will contain an alphabetical author catalogue of articles relating to the geology of North America. Each month's issue will include titles of articles received up to the 20th of the preceding month. Sheets containing this catalogue will be mailed monthly to libraries or individuals at $1.00 per year, provided a sufficient number of orders are received to cover the expense.

THE London *Times* states that the inaugural general meeting of the Automobile Club of Great Britain took place on December 8th, at the Club premises, 4 Whitehall Court, Mr. Roger W. Wallace being in the chair. The objects for which this institution has been established are described as the encouragement and development of the motor and allied industries in England, and one of its leading characteristics is that it is to be essentially a members' club, conducted quite independently of any personal interests. It aims at affording its members support in the protection and defence of their rights where menaced and at being a social club where they may obtain information and advice on all matters appertaining to motor vehicles. At the meeting yesterday the chairman gave a brief review of the position and policy of the Club, and certain routine business was transacted in connection with its organization and the formal opening of its premises for the use of members. Afterwards there was a display of various types of motor vehicles, which conveyed members and their friends for trial runs along Whitehall Court and the Thames Embankment.

UNIVERSITY AND EDUCATIONAL NEWS.

SIR W. C. MCDONALD, whose gifts to McGill University have already been very generous, has just given an additional two hundred and fifty thousand dollars to the institutution. Fifty thousand dollars of this sum is to be used as an endowment in strengthening the law faculty, and the remaining two hundred thousand dollars is for the scientific departments.

A TRAVELLING fellowship, of the value of $500, has been established at Haverford College, through a gift of some of the alumni.

THE contest over the will of the late William Lampson, bequeathing about $500,000 to Yale University, has been dismissed by the lower courts, but it is said that the case will be carried to the Supreme Court.

THE will of the late Mrs. Julia B. H. James makes the Massachusetts Institute of Technology and the Boston Museum of Arts her residuary legatees.

ON the early morning of December 18th Pardee Hall, the building containing most of the scientific departments of Lafayette College, was destroyed by fire, with the exception of the east wing. The loss on the building is probably covered by insurance, but valuable collections have been lost. The original building was erected at a cost of over $200,000, the gift of Mr. Ario Pardee, and was completely destroyed by fire in 1879.

THE registration in the University of Michigan is reported as follows:

Literary	1,297
Law	723
Medical	431
Engineering	274
Dental	220
Pharmacy	77
Homœopathic	60
Total	3,083

THE registration in the different schools of Columbia University on November 7, 1895, 1896 and 1897, respectively, was 1806, 1796 and 2033, exclusive of students of Barnard College and auditors. The college of Columbia University is small, containing only 312 students, but the graduate and professional schools have about the same number of students as the corresponding schools of Harvard University—namely, 1,762 at Harvard and 1792 at Columbia. The entrance classes in Columbia have decreased this year—582 as against 651 in 1896, the loss being in the Medical and Law Schools.

THE Cornell University Register, of which we have received an advance copy, shows a gain in numbers, the total to date being 1,790 as against 1,763 at this time last year. The University now shows the largest registration ever reached at this point in the academic year, and with the usual growth during the year it will have be-

tween 1,800 and 1,900 students in the spring term. The number of students entering the College of Civil Engineering and the College of Agriculture shows large percentages of increase, and the attendance in the New York State Veterinary College is somewhat increased. 431 degrees were conferred in June, 1897, an increase of 50 over any preceding year.

Dr. Waldemar Lindgren, of the U. S. Geological Survey, will deliver a course of lectures on mining and metallurgy at Stanford University, but has not accepted a permanent appointment, as has been announced.

Miss Julia Snow, Ph.D. (Munich), has been appointed instructor in Botany in the University of Michigan.

Dr. W. H. R. Rivers, of St. John's College, Cambridge University, has been appointed university lecturer in experimental psychology. Mr. W. L. H. Duckworth, of Jesus College, has been recognized as a lecturer in anthropology.

Mr. J. W. W. Stephens, B.A., M.B., Caius and Gonville, has been elected John Lucas Walker Student in Pathology, Cambridge University, *vice* Mr. L. Cobbett, M.A., M.B., Trinity; and Mr. H. K. Wright, M.D., C.M., McGill University, Montreal, has been awarded an exhibition of the value of £50 from the John Lucas Walker Fund.

DISCUSSION AND CORRESPONDENCE.

THE AGONOID GENUS PERCIS OF SCOPOLI.

The generic name *Percis* of Scopoli has been universally forgotten, but must be revived, and lest it should be overlooked in the great work of Drs. Jordan and Evermann I would call attention to it now. The genus for which the name was proposed by Scopoli is generally known as *Hippocephalus* of Swainson (1839). It was, however, well defined by Scopoli in 1777, and based on the *Cottus japonicus* of Pallas. The description will be found in Scopoli's 'Introductio ad Historiam Naturalem' (p. 454). The only species mentioned was *Percis japonicus*.

The genus *Percis* is the representative of a sub-family distinguished from the *Agoninæ* by the anterior position of the first dorsal fin and may be called *Percidinæ*. The other genera are *Agonomalus* and *Hypsagonus*.

Washington, D. C. Theo. Gill.

SCIENTIFIC LITERATURE.

RECENT MATHEMATICAL BOOKS.

Elements of Plane and Spherical Trigonometry. By Edwin S. Crawley, Assistant Professor of Mathematics in the University of Pennsylvania. Second edition, revised and enlarged. Philadelphia, E. S. Crawley. 8vo. Pp. 178.

In the writing of a text-book on Trigonometry there is now-a-days practically no opportunity for any assertion of individuality. The subject is of small extent, definitely bounded, and crystallized into final shape. There is, indeed, a possibility of trimming the treatment down to the absolutely indispensable part of plane trigonometry, which might then be gone over by a class in ten weeks or even less. But the whole tendency is the other way, and chapters on trigonometric equations, De Moivre's theorem, etc.—in short, a pretty complete discussion of the whole field—are now demanded in a text-book. The teacher must decide for himself how much of the whole material he will cover, and he will do well to bear in mind two facts, or rather two phases of the same fact, viz: (1) that teachers of applied mathematics constantly complain that their students do not bring to them a practical working knowledge of trigonometry; (2) that no student, however gifted or however taught, ever fully understands his elementary mathematics until he has gone through the Calculus.

Professor Crawley's book first appeared in 1890. The present second edition has been revised and enlarged by: (1) the adoption of definitions of the trigonometric functions applicable to angles of any magnitude; (2) the addition of a large number of exercises to illustrate the best methods of trigonometric reduction and analysis; (3) a large increase in the number and variety of the examples; (4) additional theorems on the described circles and Brocard's points; (5) a new chapter on De Moivre's theorem and the hyperbolic functions. A previous knowledge of logarithms is expected of the student, and the book is without tables. The plane trigonometry occupies 119 pages, and

the spherical trigonometry 51 pages. Answers are given at the end of the book, but not in cases where they would detract from the value of the examples.

Numerical Problems in Plane Geometry. By J. G. ESTILL. New York, Longmans, Green & Co. 8vo. Pp. x+144.

Of their own motion or in conformity with the unanimous recommendation of the conference of colleges and preparatory schools held at Columbia University in February, 1896, most of the better colleges have abolished the superannuated entrance requirement of a formal examination in arithmetic, and now prescribe in its stead the ability to solve numerical problems in plane geometry and a knowledge of the metric system and in some cases of logarithms. Mr. Estill's book, which is intended to furnish the requisite exercise in all three subjects, contains 49 pages of problems divided into books corresponding to the usual arrangement of the geometries in more general use. These are followed by 52 pages of recent entrance papers of an unusually large number of colleges, together with individual problems taken from similar papers. A five-place table of logarithms, with explanations and examples, occupies the next 38 pages; and the book concludes with the metric tables of weights and measures, including tables of English and metrical equivalents.

The book is not intended to take the place of other geometries, but to be used with them. The problems seem to be generally well selected. The metric system is used from the start, a favorite habit of the author being to give the data in metric units and to require the results in English measure, or *vice versa*. This is, of course, a necessary exercise within bounds, but, when carried to such an extreme as here, is calculated to give the beginner the idea that the metric system is an abominable contrivance for reckoning in terms of incommensurable numbers. Occasionally, too, the answer to a problem is conditioned on the degree of approximation to which the metric and English equivalents are to be taken, and this may well produce a feeling of uncertainty not quite in harmony with the notion of geometry as an exact science.

Plane and Solid Analytic Geometry. By FREDERICK H. BAILEY and FREDERICK S. WOODS, Assistant Professors of Mathematics in the Massachusetts Institute of Technology. Boston, Ginn & Co. 8vo. Pp. xii+371.

Wholly unlike trigonometry, analytic geometry, even in the highly restricted sense in which the name is employed by the present authors, admits of the widest variety of treatment. To what extent shall modern coordinate systems and modern methods generally be introduced? How shall the conic sections be defined? How shall the general equation of the second degree be exploited? Shall anything be said about projective relations and anharmonic ratios? These and many other questions may be settled in the greatest variety of ways by the author, and whatever his decision may be, he can with skill and care produce a highly satisfactory book.

Professors Bailey and Woods have chosen to exclude the more modern apparatus. They do not employ determinants or projective coordinates, or anharmonic ratios, but confine themselves to the ordinary Cartesian and polar coordinates and the common methods. This plan has its advantages. Beautiful and concise as the modern analytic geometry is, the beginner is perhaps not able to appreciate it at once. He must just become acquainted with a large number of new and fundamental ideas and practice himself long and slowly, before he is really able to grasp the perfect theory at all. If he learns great principles prematurely he is apt to have only a superficial understanding of them. At least this is the opinion held by many teachers.

The authors have covered the usual ground so far as plane geometry is concerned. After elementary chapters on coordinates, loci, the straight line, and transformation of coordinates follows one on the circle. The latter serves as an introduction to the conic sections, which are discussed in the next chapter on the basis of Arbogast's definition. This chapter contains also an innovation, the discussion of the general equation of the second degree with the xy term missing, a step which greatly unifies the following treatment of tangents, normals and polars. The discussion of the complete general equa-

tion occupies the last chapter of the plane geometry.

Pages 272 to 359 are devoted to solid geometry. The usual properties of the plane and line are discussed. The quadric surfaces are studied from the simplest forms of their equations, the treatment including the theory of the tangent, polar, diametral planes, conjugate diameters, circular sections and rectilinear generators. The reasoning throughout is clear and rigorous. Defects in the book are the rather scant treatment of problems in loci and the lack of good general (not numerical) examples. The book seems also disproportionately long, considering that Salmon's Conic Sections contains only 400 pages and that Smith's Conic Sections in 191 pages covers pretty well the same ground in plane geometry as the present work.

F. N. COLE.

COLUMBIA UNIVERSITY.

A Handbook for Chemists of Beet-Sugar Houses and Seed-Culture Farms. By GUILFORD L. SPENCER, D.Sc. New York, John Wiley & Sons. 1897. Pp. 475.

The beet-sugar industry, one of the most important industries of Europe, has of recent years attracted considerable attention and gained a hold on the public interest in various sections of the United States.

The painstaking and exhaustive researches into the various phases of successful beet-culture pursued for some time by the United States Department of Agriculture, largely under the able direction of Professor H. W. Wiley, have resulted in making available a vast fund of valuable information bearing on the best conditions of soil, climate, etc., for the growing of sugar-beets.

A practical confirmation of the validity of the conclusions determined by these investigations is to be found in the results obtained by the several beet-sugar factories now in successful operation in California, Nebraska, New York and elsewhere in our States. The combined capacity of these factories is, at the present, estimated to be about four thousand tons of beets, daily.

Under these conditions it was felt to be desirable to have a reliable chemical guide for those entering upon the pursuit of this newly developing branch of American industry.

The Handbook for Beet-Sugar Chemists has been written by Dr. Spencer with the express purpose of meeting this need and demand.

The author, who has been connected with the United States Department of Agriculture for some years, and who has taken an active part in its researches and investigations in beet-culture, has certainly acquitted himself ably of the self-set task.

This volume is modeled closely on the lines of the author's earlier publication, 'Handbook for Sugar Manufacturers,' which is devoted almost exclusively to the cane-sugar industry.

Nearly all of the numerous tables of the earlier work are reproduced in this, and, of course, others are added to meet the requirements of the sujects specifically treated of in these pages.

Directions for sampling and averaging beets are carefully given. The optical and chemical methods of sugar-analysis are concisely and clearly described. Analysis of the beet, the juice, the syrup, of the marsecuites and molasses and the sugars, receive attention in separate chapters, as do also the analysis of boneblack, limestone, coke, etc. Proper stress is laid on the principles upon which beet-selection is based and the methods of seed-testing are fully explained. The author's style is clear and lucid; the numerous references to authorities, given throughout the book, a valuable feature.

The problem of selecting the most desirable methods from the wealth of material stored in the current technical literature is a difficult one and has been well solved by Dr. Spencer. Care has evidently been given to the proofreading; the misspelling of the name Karcz—which is given as Kracz in both text and index—but serves, as an exception, to prove the rule. The text covers about three hundred pages; it is followed by more than a hundred pages of 'Blank Forms for Practical Use in Sugar House Work,' and some thirty pages are given to a 'Summary of Yield and Losses.' Then follows the index; in the writer's opinion it had better be placed immediately after the text, to which it refers. The book is bound in morocco;

paper and typography are very good. The insertion of advertisements, however, in a book of this kind seems, to say the least, in questionable taste.

FERDINAND G. WIECHMANN.

The History of Mankind. By PROFESSOR FRIEDRICH RATZEL. Translated by A. J. BUTLER, M. A. New York, The Macmillan Company. 1897. Vol. II., with maps and illustrations. Pp. 562. Price, $4.00.

This is the second volume of the translation of the second edition of Ratzel's 'Ethnographie,' which, for unknown reasons, the publishers have chosen to miscall 'The History of Mankind.' The first volume has already been noticed in this JOURNAL. (See SCIENCE, October 23, 1896.)

It is a handsome book, printed in clear type on excellent paper, with two maps of the distribution of the African races, ten colored illustrations of ethnographic objects and several hundred engravings in the text. These are not fancy sketches, but real helps to the student, selected from the best works of travellers or taken from authentic objects in museums of ethnography.

Professor Ratzel ranks among the chief living authorities on general ethnography, and there is no work in our tongue which surpasses this in abundance and accuracy of information. It can be recommended to readers and students without hesitation.

The present volume takes up the American Indians and the black races of Africa. The author has seen fit to interpolate between these a description of those whom he calls 'The Arctic Races of the Old World,' to wit, the Chukchis, Samoyeds, Gilyaks, Lapps, etc., usually included in the term 'Ural-Altaic Peoples.' Yet he acknowledges (p. 209) that 'we must not talk of a hyperborean race,' and intimates, what is undoubtedly the fact, that these peoples were not originally Arctic dwellers, but lived in the more genial climes to the south.

The Americans he divides, or rather meant to divide, following the artificial distinction of Waitz, into 'wild' and 'civilized' tribes; but the translator has, instead, made the distinction into 'cultured races' and 'civilized races!'—an error repeated in the table of contents and text. This unreal contrast, however, is less respected by the author in his treatment than in his plan. He recognizes the solidarity of native American culture everywhere. He also speaks positively in favor of the unity and antiquity of the race; and, with not quite so clear a note, of the independence of its culture. Nothing could more fully express a true apprehension of the American question than his words (p. 10), "Rightly understood, the New World has to supply the key to the greatest problems of anthropology and ethnology."

In details he is sufficiently full, and usually they are presented with fairness. For instance, on the mooted question of the Eskimos he decides that they are physically affined to Asian types, but in language and culture are Americans. The former is true chiefly of those in Alaska where admixture of blood may be apprehended.

His discussion of the native religions, both of America and Africa, leaves something to be desired. The time has passed when such terms as 'sun-worship,' 'moon-worship,' 'fetishism,' and the like, satisfy the student of comparative religion. These refer to externals merely and do not reveal the real religious thought. The similarities of Polynesian and American mythologies are dwelt upon (p. 147), but the translator pertinently adds in a note (p. 148) that students of Greek mythology will also 'find parallels in every part.'

It seems a deficiency to treat of totems as 'animal and plant symbols' (p. 131); they were much more than that, and often neither animal nor plant. The opinion he intimates (p. 165) that the 'Toltecs' largely created the culture of Central America is surely wide of the mark, as has been shown recently by Sapper, and his estimate of the social condition of ancient Peru (p. 201) is higher than students now would concede.

The negro races of Africa are treated with much ability. He distinguishes between the light-colored stocks, the Bushmen, Hottentots and Dwarfs of the southern and eastern parts of the continent and the Central Africans. He traces the widespread Bantu nations with precision, and gives cogent reasons for believing

their comparatively recent migration into the greater part of their present territory. The Dwarfs he considers anthropologically connected with the older inhabitants of the land and with the southern light stocks. The maps show, the one the limits of the civilizations of Africa, the other the localization of its numerous stocks. They are carefully drawn and useful.

The publication of the English version of this standard work should stimulate the study of this important branch of science. Though too large for a text-book, as a work of reference it should be in every educational library.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

Bau und Leben unserer Waldbäume (Structure and Life of our Forest Trees). By DR. M. BÜSGEN, Professor at the Forest Academy at Eisenach. Jena, Gustav Fischer. 1897. 8vo. Pp. 230.

This timely book fills a long-felt want and is, we believe, the first and only publication in any language which has ever attempted separately and in extenso and yet concisely to bring together all our knowledge of the structure and physiology of this most important group of plants; R. Hartig's and J. C. Müller's Handbooks coming next to such an attempt. This book deals, as the title indicates, with the arboreal forms of Germany; but as these are typical of all temperate zones, and the discussion is of general laws and does not refer to any particular species, it covers our own needs in this field. It is written, as the preface states, "to facilitate orientation for botanists and foresters and for all those non-professionals who desire to obtain an insight into the life and working of our forests."

From this we should not, however, anticipate that the subject has been treated in that 'popular' method of presentation which is characterized by lack of thoroughness and an attempt to please by selection rather than to instruct fully. On the contrary, the book is written in a thoroughly scientific spirit, with due regard to completeness and to the relative importance of the various parts of the subject, albeit here and there treated somewhat scantily.

The author, formerly professor at the University of Jena, has evidently brought to his task not only a thorough knowledge of the literature on the subject, at least the German and French, to which he closely and copiously refers in all particulars, but has compiled the facts with critical judgment.

Having been accustomed by his position to present the subject to a class of students who are trained to make practical use of the same in their professional pursuits, he has known how to lay most weight on the essentials from that point of view. If we add that the diction is simple and the literary style pleasing, we have given all the points that make a good and useful book. Even the usual deficiency of German books, the absence of a full index, is, in part at least, overcome by a 'register of matters not readily to be found through the table of contents.' How very deficient this register is may be illustrated by one example: Although in the chapter on causes of tree form, under the caption 'The Wind,' frost phenomena of arctic regions are discussed—and nowhere else—the index contains no reference under 'frost,' and certainly the table of contents would hardly lead one to the place. The disposition of the material appears often not very logical and hence an index is so much the more desirable.

Lack of space forbids us to go into a critical review in detail. We may only give an idea of the contents by giving titles of chapters. 'The Winter Aspect of Trees' is the title of the first, followed by 'Causes of Tree Form' as the second chapter. These two chapters could, with the aid of N. J. C. Müller's painstaking—unfortunately much overlooked—work have been profitably enlarged. The chapter on 'Buds' is followed by 75 pages devoted to the body of the tree in six chapters, discussing the 'character and functions of the formative tissues of the tree,' 'the elements of the woody tissue' and 'the bark,' the 'annual ring,' 'structure and weight of wood and heartwood formation.' The 'foliage' and 'the root' have each a large chapter devoted to them.

In the chapter on the 'Water Supply of the Tree' we note a curious misconception of an interesting experiment of Strasburger's, into which the great experimenter himself seems to

have been misled, resulting in the statement that 'the living cells of the wood do not take part in the water conduction.' The absurdity of this conclusion, philosophically apparent, can easily be demonstrated by experiment. While as a rule the unfortunate lack of knowledge of the physiology of trees is everywhere acknowledged, it appears to us that with regard to this most difficult problem the writer allows himself to become over-sanguine when he thinks that Dixon and Joly, and Askenay have solved it, however much they may have done to bring the matter under the scrutiny and explanation of physical laws and physical forces.

A chapter on the 'Derivation and Significance of the Mineral Food Elements in Trees' is followed by one on the 'Transformation and Transmission of Food Materials in the Tree,' and a chapter on 'Something about Flowering, Fruiting and Germination' ends the whole somewhat lamely, the necessity of space limitation working disadvantageously in this chapter.

The professors and students of forestry in this country, which are beginning to be called for by our necessities, will find a most convenient compendium of tree physiology in this handbook.

B. E. Fernow.

Beiträge zur Kenntniss der Septalnectarien. Von J. Schniewind-Thies. Jena, G. Fischer. 1897. Mit 12 lithographischen Tafeln. Pp. 87.

As is well known, ovarial nectaries are confined to the Monocotyledons, occurring in the Liliifloreæ and in the Scitamineæ. The authoress has made a comprehensive and thorough investigation of these, as the result of which she distinguishes seven different types of nectaries, the simplest of which occur in those genera which stand lowest in the scale of development. The development of the complex out of simpler types can be followed through a series of forms which show strikingly how the development of the vascular bundle system has gone hand in hand with that of the nectary and how the secreting power of the cells has increased in the more complex forms.

In the simplest cases the secretion of nectar takes place all over the surface of the ovary. Next we find the nectaries confined to lines which correspond to the septa and more or less depressed in clefts and furrows. In the higher types we find the nectaries in the interior of the ovary, always occurring in the septa and discharging their secretions by means of an opening which reaches the surface. These internal nectaries are often of complicated structure and may or may not be accompanied by nectaries located on the surface.

The structure of septal nectaries was investigated in a large number of genera belonging to the Liliaceæ, Amaryllidaceæ, Iridaceæ, Musaceæ, Zingiberaceæ, Cannaceæ, Marantaceæ and Bromeliaceæ.

The behavior of nucleus and cytoplasm in the secreting cells was also investigated. During the development of the ovary the secreting cells gradually become differentiated from the ordinary parenchyma cells; their cytoplasm becomes denser and they are very poor in starch, while the parenchyma cells contain an abundance of it. The nuclei of the secreting cells increase in size and become much richer in chromatin than the nuclei of the parenchyma cells; the number of nucleoli often increases. As soon as the differentiation of the tissues of the ovary is complete the secreting cells give a strong reaction with Fehling's solution. Their nuclei in many cases partially lose their walls and assume various constricted, branched and other irregular shapes. The nucleoli diminish in number, size and staining power, except in certain cases, where the reverse takes place.

During the period of their greatest functional activity the secreting cells use up starch stored in the neighboring parenchyma cells. Their cytoplasm gradually diminishes and often disappears completely. The irregular nuclei become still more irregular and often lose their walls entirely. In most cases the chromatin and nucleoli are more or less completely dissolved, but sometimes the chromatin remains intact. The colored plates illustrating changes in cell-structure are of much value, but leave much to be desired in finer details. Some experiments made by the author seem to show that a diastatic ferment is present in the nectary and its secretions.

The comprehensive and thorough investigations of Frau Schniewind-Thies constitute an

important contribution to our knowledge of the anatomy and physiology of septal nectaries and of nectaries in general. Especial mention should be made of the twelve excellent lithographic plates which illustrate nectaries in position in the flower, cross and longitudinal sections of ovaries and nectaries and the details of cell-structure in the secreting cells.

W. J. V. OSTERHOUT.

UNIVERSITY OF CALIFORNIA.

The Living Substance as Such, and as Organism. By GWENDOLEN FOULKE ANDREWS (MRS. ETHAN ALLEN ANDREWS). Supplement to Journal of Morphology, Vol. XII., No. 2. Boston, Ginn & Company. The Athenæum Press. 1897.

This work is devoted principally to discussing the more general questions of biology in the light of the very interesting facts ascertained by the examination of *living* protoplasm under the highest powers of the microscope—a method that of late has fallen into undeserved disrepute, especially so far as metazoa are concerned. Bütchli's theory of the foam-like structure of protoplasm is adopted and a number of additional observations tending to put it on a firmer foundation are recorded. The term 'Bütchli's structure,' however, is used in a sense that would probably not be subscribed to by this investigator, as designating not the foamy structure of protoplasm in general, but merely the foam whose alveoli are from ½ to 1 micron in diameter, excluding the coarser vacuolations on the one hand and on the other the 'finer foam' discovered within the substance of the partitions between the alveoli. It is to this finer foam that the principal rôle in the activities of the living substance is ascribed. The simpler movements, such as amœboid flowing seem to have for their especial organ the 'structure of Bütchli,' but the modifications of these processes, such as those taking place in the minute filose pseudopodia of many protozoa and the more complex activities of protoplasm in general, depend upon the finer foam. By this means the way is pointed out for a reconciliation of the alveolar and fibrillar theories of the structure of protoplasm. True fibres are actually found in the cell in mitosis, and at other times, but from their activities these are considered to be made up of the finer foam and to be frequently comparable to filose pseudopodia, except that they are formed on the inside of the cell.

With this structure as a basis the more general questions are considered and an interesting point of view arrived at. The important thing everywhere is the 'continuous substance' separating the alveoli. The cell is but a differentiation of this, presided over by a metabolic organ, the nucleus. In the living metazoan cells are constantly seen to be connected by a most changeable host of filose pseudopodia along which visible exchange of material may take place. Metabolism is merely a means for furnishing the 'continuous substance' with the proper internal environment, and the organism an accidental organization of it for the purpose of acting upon the external environment and thus furnishing the proper internal surroundings. Heredity is a provision of the substance for the future essentially similar to, though more complex than, the provision for a future internal environment made in injecting food. Thus the necessity for complex theories of transmission vanishes and the study of the structure and activities of the 'continuous substance' becomes of paramount importance.

Unfortunately, the poor style makes the reading much more difficult than the subject warrants. Facts and theories are mixed, unusual constructions are frequent, and in the purely descriptive parts even ambiguous expressions are encountered. That this lack of clearness is apparently due to careless composition seems to be shown by occasional sentences like the following from page 115: "If by coalescence, the substance as such showed respect to that position in the mass in which it newly found itself, exactly as in each individual it had through all its ceaseless flux respected its relative position; for it must not be forgotten that in these protoplasts the substance as such is ever changing its position in the mass or organism."

System der Bakterien, Handbuch der Morphologie, Entwickelungsgeschichte und Systematik der Bakterien, Band I., Allgemeiner Theil. Von DR. WM. MIGULA, a. o. Professor an der

technischen Hochschule zu Karlsruhe. Jena, Verlag von Gustav Fischer. 1897. Octavo of 368 pages, illustrated by 40 photographic reproductions and one diagram.

The volume before us represents the first section of a work on bacteriology. It opens with an instructive critical review of those investigations that have played so important a part in the development of our knowledge of the subject, especially as concerns morphology, classification, etc., dwelling at some length upon the historic works of Leeuwenhoek, O. F. Müller, Ehrenberg, Dujardin, Perty, Cohn, Nägeli, and DeBary.

The second section contains a discussion of the morphology, structure, modes of development and reproduction, chemical constitution, and metabolic activities of bacteria; while the third section is devoted to brief considerations of certain specific biological functions of bacteria—such, for instance, as their relation to culture media, their chromogenic functions, their specific properties of fermentation, anærobiosis, phosphorescence, and their relation to light and to temperature.

It is an excellent presentation of these phases of the subject, especially the section relating to the finer structural details of bacteria. Indeed, this portion of the work is particularly elaborate, the subject being treated with much more detail than is usual. In this respect it may serve to satisfy the demands so frequently made by the botanists for more attention on the part of bacteriologists to the morphological side of bacteriology. We must confess ourselves, however, to be of the number who not only find greater entertainment and instruction from the study of the biological functions of bacteria, but who also believe this to be much the more important line along which to develop the work.

This volume contains no reference to the relation of bacteria to the more highly-organized beings, and comparatively little upon their important rôle in the great processes of nature—points that will doubtless receive due attention in the forthcoming second volume of the work.

The literary references are full and are conveniently grouped at the end of each chapter in alphabetical order.

A. C. ABBOTT.

SOCIETIES AND ACADEMIES.

THE 97TH REGULAR MEETING OF THE CHEMICAL SOCIETY OF WASHINGTON, NOVEMBER 11, 1897.

THE first paper of the evening, read by Dr. H. C. Bolton, was entitled 'Hysterical Chemistry,' a term which he applied to the preposterous theories and claims of a certain small group of writers on chemistry who call themselves Monists. They advocate unity of matter and reject identity, replacing the latter by analogies. He gave examples of their method of reasoning, one instance being the following:

"An atom is a hypothesis,
A hypothesis has no weight, therefore
Atomic weight is a nonentity."

The speaker showed that these writers did little or no experimental work, yet claimed to be revolutionizing chemistry by their publications; also that they deserve no serious consideration.

Mr. Wirt Tassin's paper, entitled 'The Preparation of Crystals,' consisted of a review of the several methods of preparing crystals for the determination of their geometrical and physical constants, the methods being grouped under the following heads:

A. Solution, treating of the preparation of crystals of a substance from its solution in a liquid by evaporating and cooling the solution; by the reaction of soluble compounds, or by chemical changes in general. The general rules to be observed being:

1. The crystallization must proceed as slowly as possible.

2. The solution must be of the least viscosity possible.

3. The crystallizing substance must be present in the solution in the greatest quantity.

4. The crystals desired for measurement must be removed from the solution, preferably when it is at its minimum temperature, and must be quickly and completely dried in order to prevent corrosion or etch figures forming.

B. Sublimation, in which case the crystals may be obtained direct, or a non-volatile compound may be obtained as a result of chemical action between two or more volatile substances, or from a volatile substance and a gas.

C. Fusion, where the crystals are secured by slowly cooling a homogeneous magma, or by a

solution of the substance in a molten magma, and the crystals are formed either with or without pressure.

The last paper of the evening was read by Dr. E. A. de Schweinitz, and was entitled 'A Convenient Dropping Bottle.' This bottle was devised especially to be used by ophthalmologists for the purpose of keeping collyria sterile and free from dust, and at the same time one which was very easy to handle, and from which the solution could be dropped into the eye with almost any desired rapidity. It is a small pear-shaped flask with a long tubular neck at a right angle to the bottle. The end of the neck is drawn out to a moderately fine point and provided with three bends, so that the end of the tube dips downward. The object of these bends is to prevent the dust from entering the bottle. At the same time when they are filled with liquid the rest of the solution is sealed. On the side of the flask opposite the neck is a short open arm, to which a small rubber dropping bulb can be attached to regulate the rapidity with which the liquid is allowed to flow out at the bottom. A little cotton should be placed in this arm to keep out the dust. The dropper is adapted for general microchemical and volumetric work.

Professor Chas. E. Munroe made an exhibit of paraformaldehyde and the lamps used in generating formaldehyde from it. This substance is sold in the form of tablets. Contrary to the general belief, it is comparatively readily soluble in hot water. It makes a convenient laboratory source of formaldehyde. The gas is very readily given off from the tablets at comparatively low temperatures.

Mr. V. K. Chesnut exhibited specimens of *Amanita muscaria*, the fungus which caused the recent death, in Washington, of Count de Vecchj, and the serious poisoning of Dr. Daniel J. Kelly. Colored plates were shown, which showed how the fungus was mistaken for that of the closely related but edible species, *Amanita cæsarea*. Brief remarks were also made about the poisonous constituents characteristic of the two most poisonous Amanitas and their characteristic action on the human system.

V. K. CHESNUT,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON—283RD MEETING, SATURDAY, DECEMBER 4.

MR. LYMAN J. BRIGGS presented a paper on 'The Causes of Water Movement in Soils,' showing that the capillary movement of water in soils depends upon the form of the surface of the water contained in the capillary space between two soil grains in contact. The direction and relative magnitude of the pressure of films of several geometrical forms was considered, and the resultant movement of water in soils under such conditions was pointed out.

Mr. Sylvester D. Judd read a paper entitled 'Protective Adaptations of Insects from an Ornithological Point of View.' Such protectively colored insects as grasshoppers, he stated, are eaten in large quantities by practically all land birds that are to any extent insectivorous. The *Geometrid* caterpillars, which so closely simulate twigs, were found in the stomachs of a score of our commonest birds. Vile-smelling or ill-flavored insects, such as many bugs, *Carabid* beetles and *Chrysomellid* beetles, are greedily devoured by the majority of land birds. Numbers of species of insects exhibiting warning coloration and protective mimicry are selected for food by birds. The Kingbird catches the *Erastalis* fly that imitates a honey bee. It also takes honey bees, but in doing so selects only the drones. The author concluded by saying that the interaction between insects and birds does not afford the best exampie of the greatest efficiency of the protective adaptation of insects.

Dr. Theo. Gill spoke on 'The Distinctive Characters of the Molinæ and Ranzaniinæ,' saying that the family represented by the gigantic sunfish of the Northern Atlantic (*Mola mola*) is also represented by another smaller species, but which is generally regarded as nearly related—the *Ranzania truncata*. These two resemble each other so much superficially that many (including Dr. Günther) have combined them in the same genus. Anatomically, however, they are so widely different that they should be distinguished as subfamily types at least, if not as families. The subfamilies were distinguished as long ago as 1838, by Prince Bonaparte, but the characters partly transposed. The Molinæ have the skeleton mostly cartilaginous and the dorsal and anal fin rays invested in the com-

mon skin, while the Ranzaniinæ (*Orthragoriscini Bon*) have the skeleton 'Sub-osseous' and the rays distinct. The most important of the other characters were detailed.

Dr. C. W. Stiles presented a paper on 'The Honorary Ph. D.'

F. A. LUCAS, *Secretary*.

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

THE 268TH REGULAR MEETING OF THE ANTHROPOLOGICAL SOCIETY, TUESDAY, DECEMBER 7, 1897.

THE evening was devoted to a symposium upon Anthropology at the Field Columbian Museum, by Professor Wm. H. Holmes; at the American Museum of Natural History, by Professor Otis T. Mason, and at the Brussels International Exposition, by Dr. Thomas Wilson.

Professor Holmes described briefly the origin and growth of the Field Columbian Museum, of Chicago, and presented a photographic view and ground plan of the building—the Art Building of the World's Fair. The plan was colored to show the arrangements of the departments of the Museum, and especial attention was given to Anthropology. The arrangement of the collections was pointed out and the more interesting and valuable exhibits described.

Professor Otis T. Mason gave a description of the arrangement of the exhibits at the American Museum of Natural History in New York, and dwelt upon the Polynesian collection and the method of its being brought together, stating that each object, as it was obtained, was labeled with its origin, with its surrounding history and every fact that it was possible to find. He noted the difference between the various methods employed by the heads of the several museums, and believed that a diversity of methods was valuable, as it gave an opportunity for the display of each man's idea, and that stress was thus laid on the subject from many points of view.

Dr. Thomas Wilson gave a review of the Brussels International Exposition, of which Professor J. H. Gore and himself were the United States Commissioners. The Exposition was primarily a commercial one and was intended to show, first, what Belgium had to sell, and secondly, what she had to buy. The scientific department was under the direction of a number of scientific gentlemen, of whom Professor Houze was Chairman or Director-in-Chief. The scientific department was located in the great hemi-cycle, which embraced one of the great or main entrances.

Since the United States was only allowed $5,000 by Congress for its exhibit, no part of which could be expended for salaries of the Commissioners or for defraying the freight expenses of private exhibitors from America, the exhibit from this country was necessarily smaller than usual.

The anthropologic exhibit was not large, but was very good. The Belgian division was unusually fine, the prehistoric finds of the caves and grottos being very full and complete.

J. H. MCCORMICK,
Secretary.

TORREY BOTANICAL CLUB, OCTOBER 27, 1897.

THE first paper, by Mr. P. A. Rydberg, entitled 'Botanical Exploration in Montana During the Summer of 1897,' discussed the alpine flora of Montana, adding herbarium specimens and drawings. Mr. Rydberg described a collecting trip made by him and Mr. Ernest A. Bessey to Old Hollowtop, a mountain of 10,000 feet altitude in the Pony or South Boulder Mountains. Their characteristic plants, like those of other alpine regions, are remarkable for their small size and their brightly colored flowers. Most of them are but 2–3 inches high; few exceed 5 inches. The mountain side of Old Hollowtop presents a mixture of golden-yellow, indigo-blue, the richest magenta, the most delicate pink, violet and snowy white, with a carpet of the brightest green for a background. The forage plants of these alpine peaks are chiefly small cespitose clovers, and include but few grasses. Among the trees and shrubs of the alpine peaks, the most remarkable were the five small alpine willows collected, forming a light green mat covering the mountain-side above timber line. The smaller willows of the White Mountains and of the Alps and of Siberia are giants compared with these dwarfs of the Rockies. Four of these

Montana willows, with *Salix rotundifolia* from the island of Unalaska, are the smallest shrubs of *Salicaceæ* in the world. Two of these pygmies are new to science; one of which, growing often only half an inch high, is believed to be the smallest species of willow ever known.

Dr. Britton remarked that Mr. Rydberg's Montana trip of last summer was the first expedition sent out officially by the New York Botanic Garden; to which his collection of alpine plants will return.

Professor Burgess referred to a supposed age of thirty-four years for a dwarf willow of about six inches stem from Alaska, and Dr. Rydberg mentioned twelve years as perhaps the age reached by the dwarfs of his present paper, their stems dying along the rooting base too rapidly to permit great age.

Dr. Rusby spoke of Arctic willows as part of the food of beavers in northern Russia, and of reindeer.

The second paper was by Dr. John K. Small, 'On the Genus Eriogonum North of Mexico,' a genus founded by Michaux upon a single species in 1803, and increased to ninety-five in its fourth monograph, that by Dr. Sereno Watson, in 1870.

In discussing this paper, Dr. Allen contributed an entertaining description of his difficulties in bringing growing specimens of *Eriogonum Alleni* from near White Sulphur Springs to the Botanic Garden here.

Dr. Britton reported that the specimens then secured have done well in cultivation at Bronx Park, and have matured seeds.

Dr. Allen spoke of finding two or three species of *Eriogonum* in the Grand Cañon of the Colorado last summer, and described his descent of the cañon by mule trail, and also his journey to California in search of Characeæ.

Dr. Britton reported two cases of naturalization of escapes from greenhouses; the first that of a creeping form of *Ovalis corniculata*, now becoming a noxious weed at Whitestone, L. I.

The second case is that of a fern, apparently an Asplenium from a temperate habitat.

Other cases of fern naturalization which have been previously reported include that of an Adiantum in Rhode Island, by Mr. Davenport, and a Pteris in a rock-cut near the New York Central Railroad tunnel in our own city, noted by Mr. W. A. Clute.

EDWARD S. BURGESS,
Secretary.

SCIENTIFIC JOURNALS.

American Chemical Journal, December. 'Decomposition of Heptane and Octane at High Temperatures,' by R. A. WORSTALL and A. W. BURWELL: A study of the decomposition of these substances when heated in the Pintsch gas plant. The chief products of the decomposition are the olefines, methane, acetylene and the aromatic hydrocarbons. All hydrocarbons, under the same conditions of temperature, seem to yield the same products. 'Anethol and Its Isomers,' by W. R. ORNDORFF, G. L. TERRASSE and D. A. MORTON: Preparation and study of properties and molecular weight of nine isomeric substances. 'Action of Sulphur on Silicides, Production of Silicon,' by G. DE CHALMOT: Conditions under which the silicon is replaced by sulphur. 'Acetylene Diiodide,' by G. DE CHALMOT. 'The Action of Sodium upon Methylpropylketone and Acetophenone,' by PAUL C. FREER and A. LACHMAN. 'Solubility of Lead in Ammonia,' by H. ENDEMANN. 'The Decomposition of Sulphonic Ethers by Water, Acids and Salts,' by J. H. KASTLE, PAUL MURRILL and J. C. FRAZER: A study of the rate of decomposition. 'A Study of Zinc Hydroxide in Precipitation,' by V. J. HALL: Effect of chlorides and sulphates on the precipitation.

J. ELLIOTT GILPIN.

NEW BOOKS.

Repetitorium der Chemie. C. ARNOLD. Eighth edition. Revised and enlarged. Hamburg and Leipzig, Leopold Voss. 1898. Pp. xii+616.

Les végétaux et les milieux cosmiques. J. COSTANTIN. Paris, Alcan. 1898. Pp. 292. 6 fr.

Suggestions for Laboratory and Field Work in High School Geology. RALPH S. TARR. New York and London, The Macmillan Co. Pp. 100.

Memory and its Cultivation. F. W. EDRIDGE-GREEN. New York, D. Appleton & Co. 1897. Pp. 311.